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FARCOT'S IMPROVED WOOLF COMPOUND ENGINE.

In a preceding article, we have described a ventilator which is in use at the Decazeville coal mines, and which is capable of furnishing, per second, 20 cubic meters of air whose pressure must be able to vary between 30 and 80 millimeters.

In order to actuate such an apparatus, it was necessary to have a motor that was possessed of great elasticity, and that nevertheless presented no complications incompatible with the application that was to be made of it.

In the ventilation of mines it has been demonstrated that the theoretic power in kilogrammeters necessary to displace a certain number of cubic meters of air, at a pressure expressed in millimeters of water, is obtained by multiplying one number by the other. Applying this rule to the case of 20

shaft; but, the stuffing-box not being accessible so that it can be kept in a clean state, there occur after a time both leakages of steam and entrances of air.

Mr. Farcot has further simplified this last named type by suppressing the intermediate partition, and consequently the stuffing-box. The engine thus becomes direct acting, that is to say, the steam acts first upon the lower surface of the small piston during its ascent, and afterward expands in the large cylinder and exerts its pressure upon the upper surface of the large piston during its descent. Moreover, the expansion may be begun in the small cylinder, thanks to the use of a slide plate distributing valve, devised by the elder Farcot and slightly modified by the son.

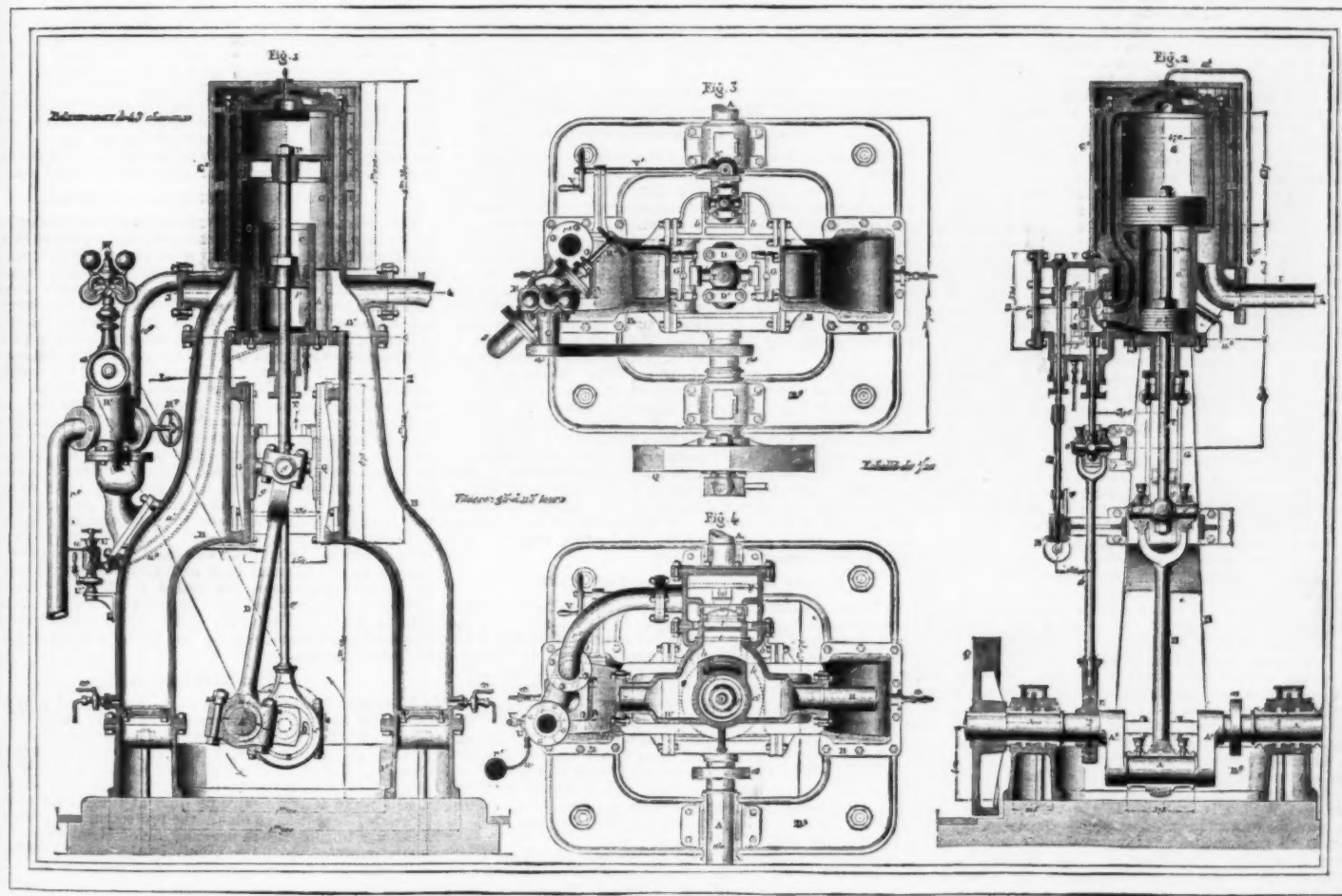
As the volume comprised between the two pistons varies with the position of the latter, annoying counter-pressures might result therefrom had not care been taken to put the chamber in communication with a reservoir of ten times

crank, A', and the bearings, g', are very long. The end the inventor had in view in constructing them thus was to diminish friction.

To the shaft, A, are keyed the coupling disks, Q, which are cast solid at a portion of their circumference situated at 180° with respect to the parts, A', of the cranked shaft, the object of this being to balance the latter as well as a portion of the connecting rod, D.

The shaft, A, also receives the eccentric, E, of the slide valve, the rod, e, of which is jointed to the slide valve rod through the intermedium of a cross-head, e', analogous to that of the pistons, and which, like the latter, runs on guides held by the support, b.

The two pistons, p and P, are mounted very simply on the rod, T, as shown in Fig. 1, and slide in cylinders, c and C, whose diameters are respectively equal to 270 and 470 millimeters.



FARCOT'S IMPROVED WOOLF COMPOUND ENGINE.

cubic meters under a hydrostatic pressure of 30 millimeters, we find:

$$20 \times 30 = 600 \text{ kilogrammeters.}$$

In the case of a pressure of 80 millimeters, we have:

$$20 \times 80 = 1,600 \text{ kilogrammeters.}$$

If we admit a product of 50 per cent., we shall have in the two cases, for the power actually necessary:

$$\frac{600}{0.5} = 1,200 \text{ kilogrammeters, or 16 H. P.}$$

$$\frac{1,600}{0.5} = 3,200 \text{ kilogrammeters, or 43 H. P.}$$

Such are the limits within which the power of the motor should be able to vary.

After successively examining all the different systems of engines now in existence, and finding none which, in a plain form, was capable of fulfilling the conditions imposed, Mr. E. D. Farcot decided to study out one for himself. Almost from the very beginning of his researches in this direction, he adopted the Woolf system, which is one that permits of great variation in the expansion, and one in which the steam under full pressure acts only upon the small piston. There are many types of this engine in use, all of which present marked defects. In one of them, the large cylinder is arranged directly over the small one so as to have but a single rod for the two pistons; and the two cylinders have then one bottom in common, which is furnished with a stuffing-box in which the rod moves. With this arrangement we have but a single connecting rod and a single crank for the

greater capacity, and which is formed by the interior of the frame. This brings about an almost constant counter-pressure.

The type of motor under consideration, which we represent in the accompanying plate, is possessed of remarkable simplicity. The number of parts is reduced to the extreme limits; it works at high speed without perceptible wear; it does not require those frequent repairs that many other cheap engines do; and the expansion of the steam is utilized without occasioning violent shocks in the parts which transmit motion. Finally, the plainness of the whole apparatus is perfectly in accordance with the uses for which it was devised.

Details of Construction.—Figs. 1 and 2 represent the motor in vertical section made in the direction of two planes at right angles. Figs. 3 and 4 are horizontal sections made respectively in the direction of the lines 1-2 and 3-4.

The frame, which is of cast iron and entirely hollow, consists of two uprights, B, connected at their upper part by a sort of cap, B', which is cast in a piece with the two cylinders, C and C'. The whole rests upon a base, B'', which is itself bolted to the masonry foundation.

Each of the uprights is provided internally with projecting pieces for receiving the guides between which slides the cross-head, g, of the piston rod. The slides terminate in two lubricating cups designed for oiling the surfaces submitted to friction.

The cross-head carries two bearings, g', to which is jointed the forked extremity, D, of the connecting rod, whose opposite extremity receives a strap that embraces the cranked end of the driving shaft, A. It will be remarked that the

The slide valve box, F, is bolted to the cap-piece, B', as seen in Fig. 4. As for the slide valve, f, its arrangement may be distinguished in section in Fig. 2. Its eccentric is keyed at 170° so as to admit steam into the small cylinder during the entire travel, which latter is 470 mm.

To permit of the expansion beginning in the small cylinder, Mr. Farcot has added a sliding plate, f', which abuts at every stroke against the stops, s. These latter are affixed to the rod, S, whose lower extremity is threaded, and which may be moved vertically, as slightly as may be desired, through the medium of the pinions, S', when the hand-wheel, V, is revolved. A datum point, e, and a graduated socket, e', allow the position of the stops, s, and consequently the degree of expansion, to be known.

Steam is introduced into the small cylinder through the conduit, i, and its passage into the large one is effected through the conduit, f. The escape into the interior of the frame is effected, after expansion, through the horizontal conduit, h. The pipe, H, leads this exhaust steam to the open air.

The pipe, I, leads steam into the jacket, C', of the large cylinder, this latter being provided in addition with a casing of wood, C'', so as to completely prevent chilling.

The regulator, R, is after the Buns pattern, and is set in motion by a belt which runs over the pulleys, a and a'. It is mounted upon a distributing box, R', to which steam is led from the boiler by the pipe, r'. After traversing this box, the steam enters the slide valve box through the pipe, r'', its admission thereto being regulated by the hand-wheel, R'', which likewise serves for stopping the engine.

The cocks, z, are fixed at the base of the uprights, B, for

drawing from the frame the condensed water that has accumulated therein.

The lubricating apparatus, V, which communicates, through the tube, u, with the steam port, r, permits oil to be sent to the large and small cylinders through the tubes, u' and u".

Mr. Farcot has recently adapted this type of motor to the direct running of electric machines that are required to make 400 revolutions per minute.—*Publication Industrielle.*

IRON AND STEEL.

At the recent meeting of the Iron and Steel Institute, London, the president-elect (Mr. Bernard Samuelson, M.P.), delivered the following inaugural address:

THE WORLD'S PRODUCTION OF PIG IRON.

He showed that the world's production of pig iron has increased in round numbers from 10,500,000 tons in 1869 to 20,500,000 tons in 1883. The blast furnaces of 1869 produced on the average a little over 180 tons per week, with a temperature of blast scarcely exceeding 900° Fahr. The consumption of coke per ton of iron varied from 25 to 30 cwt. To-day our blast furnaces produce on the average upward of 300 tons per week.

The Consett Company have reached a production of 3,400 tons in four weeks, or 850 tons per week, and of 134 tons in one day from a single furnace.

From the United States we have authentic accounts of an average production of 1,120 tons per furnace per week having been attained, and that even this great output has lately been considerably exceeded there. Both as to consumption of fuel and wear and tear, per ton of iron produced, these enormous outputs are attended with economy.

HEAT OF THE BLAST.

In the case of the Consett furnace they were obtained although the heat of the blast was under 1,100° Fahr., while heats of 1,500° to 1,600° are not uncommon at the present day in brick stoves, thanks to the application of the regenerating principle of ex-president Sir W. Siemens.

But an economy which promises to be of great importance is now sought in the recovery and useful application of those constituents of coal which, in the coking process, have hitherto been lost; or, as an alternative, in a similar recovery in those cases in which the coal is charged in a raw state into the blast furnace, as is the practice in Scotland and elsewhere. This recovery of the hydrocarbons and the nitrogen contained in the coal, and their collection as tar and ammoniacal liquors, and subsequent conversion into sulphate of ammonia as to the latter, and into the various light and heavy paraffin oils and the residual pitch as to the former, have now been carried on for a considerable time at two of the Gartsherrie furnaces; and they are already engaged in applying the necessary apparatus to eight more furnaces. In the coke oven the recovery of these by-products—if that name can be properly applied to substances which yield the most brilliant colors, the purest illuminants, and the flesh-forming constituents supplied by the vegetable world—would appear at first sight to be simpler; but it has presented its own peculiar difficulties; the chief of which was, or was believed to be, a deterioration in the quality of what has hitherto been the principal, but what may, perhaps, come to be regarded hereafter as the residual product, namely, the coke. But the more recent experience of Messrs. Pease, at Crook, appears not to justify this opinion. You will see on our table specimens of the coke produced in the Carves-Simon oven, yielding 75 to 77 per cent. of coke from the Pease's West coal, which they have now had at work for several months. Twenty-five of these ovens are at work, and the average yield of ammoniacal liquor per ton of coal has been 30 gallons of a strength of 7° Twaddell, valued at 1d. per gallon at the ovens; the quantity of tar per ton has been 7 gallons, valued at 3d. per gallon. These products would therefore realize 4s. 3d. per ton of coal. Of course the profit on the ton of coke is considerably more, and to this has to be added the value of the additional weight of coke, which in the ordinary beehive ovens from coal of the same quality is only 60 per cent., or in beehive ovens having bottom flues about 66 per cent., while in the Carves ovens it is, as I have said, upward of 75 per cent. Against these figures there is a charge of 1s. 4d. per ton of coke for additional labor, including all the labor in collecting the by-products; the interest on the first cost of the plant, which is considerable, and probably some outlay for repairs in excess of that in the case of ordinary ovens, has also to be charged. Mr. Jameson takes credit for the combustible gas, which is used up in the Carves ovens, but which remains over in his process, and is available, though not nearly all consumed, in raising steam for the various purposes of a colliery, including, no doubt, before long, the generation of electricity for its illumination. It is right to state that prior to 1879 Mr. Henry Altken had applied bottom flues for taking off the oil and ammoniacal water to beehive ovens at the Almond Ironworks, near Falkirk. He states that the largest quantity of oil obtained was eleven gallons, the specific gravity varying from 0.925 to 1.000, and that the water contained a quantity of ammonia fully equal to 5½ lb. of sulphate of ammonia to the ton of coal coked. The residual permanent or non-condensed gases were allowed to issue from the end of the condenser pipe, and were burnt for light in the engine-houses, but it was intended to force them into the oven again above the level of the coke. Owing to the works being closed, nothing has been done with these ovens for some years. I may mention, by the way, that it is proposed to apply the principle of Mr. Jameson's process to the recovery of oil and ammonia from the smouldering waste heaps at the pit-bank, by the introduction into these of conduits resembling those which he applies to the bottom of the beehive oven. There is every reason to expect that one or more of these various methods of utilizing valuable products which are at present lost will be carried to perfection, and will tend to cheapen the cost at which iron can be produced, and still further to increase its consumption for all the multifarious purposes to which it is applied.

WONDERFUL USES AND DEMAND FOR IRON AND STEEL.

But the world's annual production of 20,000,000 tons of pig iron is itself sufficiently startling, and without attempting to present to you the statistics of all its various uses—for which, in fact, we do not possess the necessary materials—the increased consumption of more than 9,000,000 tons since 1869 becomes conceivable when we consider how some of the great works in which it is employed have been extending during that or even a shorter interval. And of these I need only speak of the world's railways, of which there were in 1872 155,000 miles, and in 1883 not less than 260,000, but probably more nearly 265,000 miles. In the

United States alone about 60,000 miles of railway have been built since 1869—the year, I may remind you in passing, in which the Atlantic and Pacific States of the Union were first united by a railway; while in our Indian Empire the communication between Calcutta and Bombay was not completed till the following year.

The substitution of iron and steel for wood in the construction of ships, and the enormous increase in the tonnage of the world, in spite of the economy arising from the employment of steamers in place of sailing ships, is perhaps the element of increased consumption next in importance to that of railways. I do not think that the materials are available for estimating with any accuracy the amount of this increase, but I believe I am rather understating it if I take the consumption of iron and steel used last year throughout the world in shipbuilding as having required considerably more than 1,000,000 tons of pig iron for its production, and that this is not far short of four times the quantity used for the same purpose before 1870. And so all the other great works in which iron and steel are employed have increased throughout the world. It would be tedious to indicate them all.

Among those which rank next in importance to the preceding, I will only name the works for the distribution of water and gas, which in this country and in the United States have been extended in a ratio far greater than that of the increase of the population, and which, since the conclusion of the Franco-German war, and the consolidation of the German and Italian States, are now to be found in almost every European town of even secondary importance; and bridges and piers, in the construction of which iron has almost entirely superseded every other material.

It is difficult to imagine what would have been the state of the iron industry in this country if we had been called upon to supply our full proportion of the enormously increased demand for iron. To meet that proportion, the British production of pig iron should have been close on 11,000,000 tons in 1882, a drain on our mineral resources which cannot be replaced, and which, especially if continued in the same ratio, would have been anything but desirable. Fortunately, as I am disposed to think, other countries have contributed more than a proportionate amount to the increase in the world's demand; and, paradoxical as it may appear, it is possible that, to this country at least, the encouragement given by protective duties to the production of iron abroad may have been a blessing in disguise.

PROGRESS OF BESSEMER STEEL.

To speak of the enormous increase in the production of steel by the introduction of the Bessemer process has become a commonplace on occasions like the present, and yet I doubt whether its real dimensions are generally known or remembered. In 1869 the manufacture of Bessemer steel had already acquired what was then looked upon as a considerable development in all the principal centers of metallurgical industry, except the United States, but including our own country, Germany, France, and Austria, and the world's production in that year was 400,000 tons. Last year it was over 5,000,000 tons, and it has doubled in every steel-producing country during the last four years, except in France, where, during this latter period, the increase has not been much more than one-fourth. What is almost as remarkable as the enormous increase in the production of Bessemer steel is the great diminution in its cost. In the years preceding 1875, the price of rails manufactured from Bessemer ingots fluctuated between £10 and £18 per ton, and I remember Lord George Hamilton when he was Under-Secretary for India of Lord Beaconsfield's administration in 1875 or 1876, congratulating himself on his good fortune in having been able to secure a quantity of steel rails for the Indian government at £13 per ton. Within the last three years we have seen them sold under £4 10s. in this country, and £5 10s. in Germany and Belgium.

LATEST IMPROVEMENTS IN IRON MAKING.

This great reduction is the cumulative result of a number of concurrent improvements, partly in the conversion of the iron, and partly in the subsequent treatment of the ingot steel. In most of the great steelworks the iron is no longer remelted, but is transferred direct from the blast furnace to the converter, a practice which originated at Terre-Noire, and was long considered in this country to be incompatible with uniformity in the quality of the steel produced. The turn-out of the converter plant has been gradually increased in this country to more than four times that of fourteen years ago, while the practice of the United States is stated by a recent visitor to have reached such an astounding figure that I am afraid to quote it without confirmation; but the greatest economy arises no doubt in the labor and fuel employed in the mill.

Cogging has taken the place of hammering. Even wash-heating will be, if it is not already, generally dispensed with by the soaking process of our colleague, Mr. Giers, which permits of the ingot, as it leaves the pit, being directly converted into a rail.

STEEL RAILS 150 FEET LONG.

An extract from a letter addressed to me by our colleague, Mr. E. W. Richards, will describe better than any words of mine the perfection at which steel rail mills have arrived. He says, "Our cogging rolls are 48 in. diameter, and the roughing and finishing rolls are 30 in. diameter. We roll rails 150 feet long as easily as they used to roll 31 feet. Our ingots are 15¼ inches square, and weigh from 25 to 30 cwt., according to the weight of rail we have to roll. These heavy ingots are all handled by machinery. We convey them by small locomotives from the Bessemer shop to the heating furnaces, and by the same means from the heating furnaces to the cogging rolls."

So quickly are these ingots now handled that we have given up second heating altogether, so that after one heat the ingot is cogged from 15¼ inches square down to 8 inches square, then at once passed on to the roughing and finishing rolls, and finished in lengths, as I have said before, of 150 ft., then cut at the hot saws to the lengths given in the specifications, and varying from 38 ft. to about 21 ft. The 38 ft. lengths are used by the Italian 'Meridionale' Railway Company, and found to give very satisfactory results. I need scarcely say that in a mill like this, the expenditure of fuel and labor and the loss by waste caused by crop ends are reduced to a minimum.

BASIC STEEL.

The enormous production of steel has required the importation of large quantities of iron ore of pure quality from Spain, Algeria, and elsewhere, into this country, France, Belgium, Germany, and the United States; and these supplies have contributed greatly to the reduction in the price of steel to which I have referred, and what is, perhaps, of

equal importance, they have prevented the great fluctuations of price which formerly prevailed. In 1869 this trade was in its infancy, and almost confined to the importation of the Algerian ores of Mokta el Hadid into France, while in 1882 Bilbao alone exported 3,700,000 tons of hematite ores to various countries to which the exports from the south of Spain, Algeria, Elba, Greece, and other countries have to be added. Great Britain alone imported 3,000,000 tons of high class, including manganiferous iron ores last year.

It is questionable whether the mines of pure iron existing in Europe would long bear a drain so great and still increasing; but happily the question no longer presses for an answer, because the problem of obtaining first-class steel from inferior ores has been solved by the genius of our colleagues, Mr. Snelus and Messrs. Thomas and Gilchrist, and by the practical skill and indomitable resolution of Mr. Windsor Richards. It is no part of the duty of the Institute to assign to each of these gentlemen his precise share in the development of the basic process. Whatever those shares may be, I feel sure you will agree with your council as to the propriety of their having awarded a Bessemer medal to two of these gentlemen—Messrs. Snelus and Thomas—to Mr. Snelus as the first who made pure steel from impure iron in a Bessemer converter lined with basic materials; to Mr. Thomas, who solved the same problem independently, and so clearly demonstrated its practicability to Mr. Richards by the trials at Blaenavon, as to have led that gentleman to devote all his energies and the great resources of the Estons Works to the task of making it what it now is, a great commercial success. All difficulties connected with the lining of the converter and in insuring a durability of the bottom, nearly, if not quite, equal to that in the acid process, appear now to have been successfully surmounted, and I am informed by Mr. Gilchrist that the present production of basic steel in this country and on the Continent is already at the rate of considerably more than 500,000 tons per annum, and that works are now in course of construction which will increase this quantity to more than a million tons.

Our members will have the opportunity of seeing the process at work during their visit to Middlesbrough, at the Estons Works of Messrs. Bolekew, Vaughan & Co., which are now producing 150,000 tons per annum of steel of the highest quality from the phosphoretic Cleveland ores; and also at the North-Eastern Steel Company's Works. I believe it is the intention of the latter company to make a pure, soft steel suitable for plates, for which, according to the testimony of Messrs. Delafond, of Creuzot, and others, the basic steel is peculiarly suitable on account of its remarkable regularity. I shall have the pleasure of presenting to Mr. Snelus the medal which he has so well deserved.

HONORS AND REWARDS TO INVENTORS.

The presentation to Mr. Thomas is deferred. His arduous labors having affected his health, he is at present in Australia, after having, I am happy to say, received great advantage from the voyage; and his mother, justly proud of his merits, and appreciating fully the value of their recognition by the award which we have made, has requested us not to present the medal by proxy, but to await the return of her son, in order that it may be handed to him in person. But honors, whether conferred by the Crown, by learned bodies, or, as in this case, by the colleagues of the recipient, though they stimulate invention, are by themselves not always sufficient to encourage inventors to devote their labor to the improvements of manufactures or to induce capitalists to assist inventors in the prosecution of costly experiments; and it is on this account that the protection of inventions by patent is a public advantage. The members of our profession, unlike some others, have not been eager to apply for patents in the case of minor inventions; on the contrary, they have freely communicated to each other the experience as to improvement in detail which have resulted from their daily practice. It has been well said that all the world is wiser than any one man in it, and this free interchange of our various experiences has tended greatly to the advancement of our trade. But new departures, like the great invention of Sir H. Bessemer, and important improvements like the basic process, require the protection of patents for their development.

THE PATENT LAWS.

The subject of the patent laws is, therefore, of interest to us, as it is to other manufacturers. You are aware that the Government has introduced a bill for amending these laws. If that bill should pass, it will effect several important changes. It will, in the first place, enable a poor man to obtain protection for an invention at a small cost; secondly, it will make it more difficult than at present for a merely pretended invention to obtain the protection and prestige of a patent; thirdly, it will promote the amalgamation of mutually interdependent inventions by the clause which compels patentees to grant licenses; and, lastly, it will enable the Government to enter into treaties with other powers for the international protection of inventions. If you should be of opinion that these are objects deserving of your support, I hope that you will induce your representatives in the House of Commons to do all that is in their power to assist the Government in passing them into law.

GROWTH OF THE SIEMENS-MARTIN PROCESS.

The growth of the open hearth or what is known as the Siemens-Martin process of making steel, during the interval from 1869 to the present time, has been no less remarkable than that of the Bessemer process; for though it has not attained the enormous dimensions of the latter, it has risen from smaller beginnings. Mr. Ramsbottom started a small open-hearth plant at the Crewe Works of the London and North-Western Railway, in 1868, for making railway tires, and the Landore Works were begun by Sir W. Siemens in the same year. On the Continent there were a few furnaces at the works of M. Emile Martin, at the Firming Works, and at Le Creuzot. None of these works, I believe, possessed furnaces before 1870, capable of containing more than four-ton charges, ordinarily worked off twice in twenty-four hours. The ingots weighed about 6 cwt., and the largest steel casting made by this process, of which I can find any account, did not exceed 10 cwt. At the present day, we have furnaces of a capacity of from 15 to 25 tons, and by combining several furnaces, single ingots weighing from 120 to 125 tons have been produced at Le Creuzot. The world's production of open-hearth steel ingots for ship and boiler plates, propeller shafts, ordnance, wheels and axles, wire billets, armor plates, castings of various kinds, and a multiplicity of other articles, cannot have been less than from 800,000 to 850,000 tons in 1882.

The process itself has followed two somewhat dissimilar lines. In this country, iron ores of a pure quality are dissolved in a bath of pig iron, with the addition of only small quantities of scrap steel and iron. At Le Creuzot large

quantities of wrought iron are melted in the bath. This iron is puddled in modified rotating Danks furnaces containing a charge of a ton each. The furnaces have a midrib dividing the product into two balls of 10 cwt., which are abridged under a 10-ton hammer. The iron is of exceptional purity, containing less than 0.01 per cent. of phosphorus and sulphur. I should add that the two rotating furnaces produce 50 tons of billets in twenty-four hours.

PRESENT PRODUCTION OF WROUGHT IRON.

Meanwhile, the world's production of wrought iron has not been stationary. I cannot give very accurate figures, as the statistics of some countries are incomplete, while in others the output of puddled bar only, and not that of finished iron, has been ascertained. The nearest estimate which I can arrive at is a production increased from about 5,000,000 tons in 1869 to somewhat over 8,000,000 tons of finished iron in 1882; an increase all the more remarkable when it is considered that at the present time iron rails have been almost entirely superseded by steel. It is due, no doubt, in part to the extensive use of iron plates and angles in shipbuilding; but, apart from these, and from bars for the manufacture of tin-plates, the consumption has increased for the numberless purposes to which it is applied in the world's economy.

PROGRESS OF PUDDLING.

There has been no striking improvement in the manufacture of puddled iron, partly on account of the impression that it is doomed to be superseded by steel. Mechanical puddling has made but little progress, and few of the attempts to economize fuel in the puddling furnace, by the use of gas or otherwise, have been successful. I would, however, draw attention to the remarkable success which has attended the use of the Bicheroux gas puddling and heating furnaces at the works of Ougrée, near Liège. The works produce 20,000 tons of puddled bars per annum, in fifteen double furnaces. The consumption of coal per ton of ordinary puddled bar is under 11 cwt., and per ton of "for a fin grain" (puddled steel, etc.) 16 cwt. The gas is produced from slack, and the waste heat raises as much steam as that from an ordinary double furnace. The consumption of pig iron per ton of puddled bar was rather less than 21½ cwt. for the year 1882; and that of "mine" for fettling was 33 lb. The repairs are said to be considerably less than in the ordinary furnaces, and the puddlers earn from 25 to 30 per cent. more at the same tonnage rate. I have already mentioned the large consumption, reckoned in tons of pig iron, of the materials for shipbuilding.

GROSS OF IRON AND STEEL SHIP BUILDING.

It may be useful to add that the gross tonnage of iron vessels classed during 1882 by the three societies of Lloyd's, the Liverpool Registry, and the Bureau Veritas was 1,142,000, and of steel 143,000 tons, and that the proportion of steel to iron vessels is increasing from year to year. I am informed by our colleague, Mr. Pearce, of Messrs. Elder's firm, that the largest vessel built by them in 1869 was an iron steamer, of 3,063 tons gross, with compound engines of 3,000 horse power, working at 60 lb. pressure; speed, 14 knots.

A GIGANTIC STEAMER.

The largest vessel now on the ways is the Oregon, of 7,400 tons gross, and 13,000 horse power; estimated speed, 18 knots. The superficial area of the largest plates in the former was 22½ square feet; that of the largest plate in the latter is 206 square feet. The Oregon is an iron vessel, but some of the largest vessels now being built by Mr. Pearce's firm are of steel.

The information which I have obtained from Messrs. Thomson, of Glasgow, is especially emphatic as to the supersession of iron by steel in the construction of ships. They say that large steel plates are as cheap as iron ones, and that they have never had one bad plate or angle in steel. This is confirmed by Mr. Denny, who says: "Whenever our shipwrights or smiths have to turn out anything particularly difficult in shape, and on which much 'work' has to be put, they will get hold of a piece of steel if they can."

REMARKABLE MACHINERY AND TOOLS.

It will be readily understood that the rolls, the hammers, the machinery for punching, drilling, planing, etc., used in the manufacture and preparation of plates and angles for shipbuilding and armor plates are on a scale far different at the present date from what they were in 1869. Perhaps the most striking examples of powerful machinery for these purposes are the great Creuzot hammer, the falling mass of which has recently been increased to 100 tons, and the new planing machines at the Cyclops Works, which weigh upward of 140 tons each, for planing compound armor plates 19 in. thick and weighing 57 tons.

THE FUTURE OF IRON AND STEEL.

Some of the eminent men who have preceded me in this chair have made their inaugural address the occasion for a forecast of the improvements in practice and the developments in area of the great industry in which we are engaged. Several of these forecasts have been verified by the results; in other cases they have proved to be mistaken; nor need this excite surprise. I believe that few would have predicted, when the consideration of the subject was somewhat unfortunately deferred through want of time at our Paris meeting of 1878, that the basic process would so speedily prove itself to be of such paramount value as we now know it to possess. On the other hand, the extinction of the old puddling process has long been the favorite topic of one of our most practical ex-presidents, and I have shown you by figures that the process is not only not yet dead, but that the manufacture of wrought iron is actually flourishing side by side with that of its younger brother, steel. How much longer this may continue to be the case it would not be easy to foretell, but there can be little doubt that, just as for rails steel has superseded iron as being cheaper and vastly more durable, so it will be in regard to plates for constructive purposes, and especially for shipbuilding. It is now an ascertained fact that steel ships are as cheap, ton for ton of carrying capacity, as iron ones, and it is probable that as the demand for, and consequently the production of, steel plates increases, steel ships will become cheaper than those built of iron; but, what is more important, they have been proved to be safer, and no time can long elapse before this will tell on the premiums of insurance. Steel forgings also are superseding, and must to an increasing extent, supersede iron; while it is probable that the former will in their turn be replaced for many purposes by the beautiful solid steel castings which are now being produced by the Terre-Noire Company in France, the Steel Company of Scotland, and other

manufacturers, by the Siemens-Martin process. On this subject I believe Mr. Parker can give us valuable information; and on a cognate branch, namely, the production of steel castings from the Bessemer converter, an interesting paper will be submitted to us by Mr. Allen at our present meeting.

I may here mention incidentally, that I have of late had occasion to make trials on a considerable scale of edge tools made from Bessemer steel, which show that, except perhaps in the case of the finest cutlery, there is no longer any occasion to resort to the crucible for the production of this quality of steel.

RAILWAY DEMAND FOR IRON AND STEEL.

But it is in the further development of the world's railways that we must mainly look in the future, as in the past, for the support of our trade. In India the railway between Calcutta and Bombay was only completed in 1870, and at the present time, with a population of 250,000,000, it has less than 10,000 miles of railway, while the United States, with only 50,000,000, possesses more than 100,000 miles. In other words, the United States have fifty times as many miles of railway in relation to the population as India. Even Russia in Europe has 14,000 miles, or, in relation to its population, nearly five times as great a mileage as our Indian Empire; and the existing Indian railways are so successful pecuniarily, and give such promise of contributing to the wealth of the Indian people—or perhaps it would be more just to say, of rescuing them from their present state of poverty and depression—that it should be the aim of those who are responsible for the well-being of our great dependency to give to its railways the utmost and most rapid development.

THE "SWALLOW," A NEW VEHICLE.

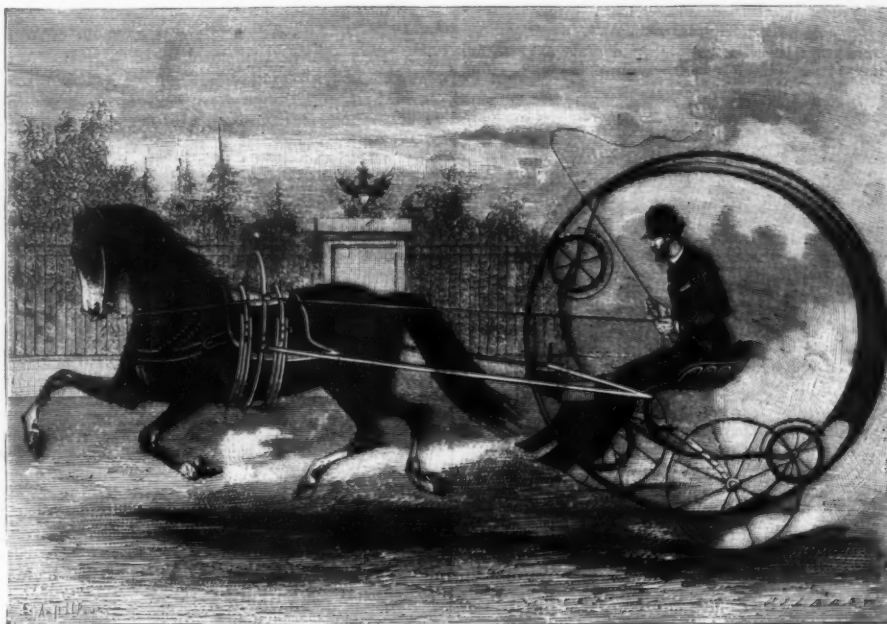
The graceful vehicle shown in the accompanying cut is much used in Poland and Russia, and we believe that it has already made its appearance at Paris. The builder is Mr. Henri Barycki, of Warsaw, who has very skillfully utilized a few very curious mechanical principles in it.

The driver's seat is fixed in the interior of a wide ring to which are fastened the shafts. This ring revolves, by the aid of three pulleys or small wheels, within the large ring resting on the ground. It will be seen that when the horse is drawing the vehicle, the friction of this large wheel against the ground being greater than that of the concentric one within it, the latter will revolve until the center of gravity of the whole is situated anew in a line vertical to the point at which it bears on the ground. The result of such an arrangement is that the driver rolls on the large wheel just as he would do on the surface of an endless rail. As may be conceived, the tractive stress is, as a consequence, considerably diminished.

There are two side wheels which are connected by a flexible axle to the seat of the carriage, but these have no other purpose than that of preventing the affair from turning to one side or the other.

The "swallow," for so it is named, is made entirely of steel and wrought iron. It is very easily kept clean; the horse can be harnessed to it in three minutes; and, aside from its uses for pleasure, it is capable of being utilized in numerous ways.—*La Nature*.

[Our excellent contemporary, *La Nature*, is mistaken in its account of the above vehicle. It is an American invention



THE SWALLOW.

As to the United States themselves, I look upon their railways as a little more than the main arteries from which an indefinitely large circulating system will branch out. Besides these countries I need only allude to the Dominion of Canada, whose vast territory bids fair to rival that of the United States in agricultural importance, to our Australian colonies, to Brazil, and other countries in which railways are still comparatively in their infancy, to show that, quite apart from the renewal of existing lines, the world's manufacture of rails has an enormous future before it.

RELATIONS BETWEEN EMPLOYERS AND WORKMEN.

I look on the excellent feeling which happily prevails between the employers and the workmen in our great industry as another of the most important elements of its future prosperity. It confers honor on all concerned that by our Boards of Conciliation and Arbitration, ruinous strikes, and even momentary suspensions of labor, are avoided; and still more that masters like our esteemed Treasurer, Mr. David Dale, should deserve, and that large bodies of workmen should have the manliness and discernment to bestow on him, the confidence implied in choosing him so frequently as an arbitrator. I believe that similar friendly relations exist in some, at any rate, of the other great centers of the iron and steel industries, and that although our methods may not be adapted to the habits of all, there is no country in which some way does not exist, or may not be found, to avoid those contests which were so fatal to our prosperity in former days. Lastly I regard as one of the most hopeful signs of the future the increased estimate of the value of science entertained by our practical men. In this respect we may claim with pride that the Iron and Steel Institute has been the pioneer, at any rate, so far as this country is concerned. But the conviction that the elements of science should be placed within the reach of those who occupy a humble position in the industrial hierarchy than we do who are assembled here is rapidly spreading among us. The iron manufacturers of Westphalia have been the first to found an institution in which the intelligent and ambitious ironworker can qualify himself by study for a higher position, and I hope when this Institute visits Middlesbrough in the autumn, some progress will have been made in that locality toward the establishment of a similar school. Other districts will doubtless follow, and the result will be, to quote the words of Sir W. Siemens on a late occasion, that "by the dissemination of science a higher spirit will take possession of our artisans; that they will work with the object of obtaining higher results, instead of only discussing questions of wages." It is on the mutual co-operation in this spirit of all the workers of every grade in our great craft that we may build the hope—nay, that we may even cherish the certain expectation—of placing it on even a higher eminence than that which it has already attained.

and was first published, with engraving, in the *SCIENTIFIC AMERICAN*, December 10, 1882.]

BORING AN OIL WELL.

HOW THE HOLE WAS MADE AND THE OIL BROUGHT UP.

A LETTER from Bradford, Pa., says: The machinery used in boring one of these deep oil wells, while simple enough in itself, requires nice adjustment and skill in operating. First comes the derrick, sixty feet high, crowned by a massive pulley.

The derrick is a most essential part of the mechanism, and its shape and height are needed in handling the long rods, piping, casting, and other fittings which have to be inserted perpendicularly. The borer or drill used is not much different from the ordinary hand arm of the stone cutters, and the blade is exactly the same, but is of massive size, three or four inches across, about four feet long, and weighing 100 or 200 pounds. A long solid rod, some thirty feet long, three inches in diameter, and called the "stem," is screwed on the drill. This stem weighs almost a ton, and its weight is the hammer relied on for driving the drill through dirt and rock. Next come the "jars," two long loose links of hardened iron playing along each other about a foot.

The object of the jars is to raise the drill with a shock, so as to detach it when so tightly fixed that a steady pull would break the machinery. The upper part of the two jars is solidly welded to another long rod called the sinker bar, to the upper end of which, in turn, is attached the rope leading up to the derrick pulley, and thence to a stationary steam engine. In boring, the stem and drill are raised a foot or two, dropped, then raised with a shock by the jars, and the operation repeated.

If I may hazard a further illustration of the internal boring machinery of the well, let the reader link loosely together the thumbs and forefingers of his two hands, then bring his forearms into a straight line. Conceiving this line to be a perpendicular one, the point of one elbow would represent the drill blade, the adjacent forearm and hand the stem, the linked finger the jars, and the other hand and forearm the sinker bar, with the derrick cord attached at a point represented by the second elbow. By remembering the immense and concentrated weight of the upright drill and stem, the tremendous force of even a short fall may be conceived. The drill will bore many feet in a single day through solid rock, and a few hours sometimes suffices to force it fifty feet through dirt or gravel. When the debris accumulates too thickly around the drill, the latter is drawn up rapidly. The debris has previously been reduced to mud by keeping the drill surrounded by water. A sand pump, not unlike an ordinary

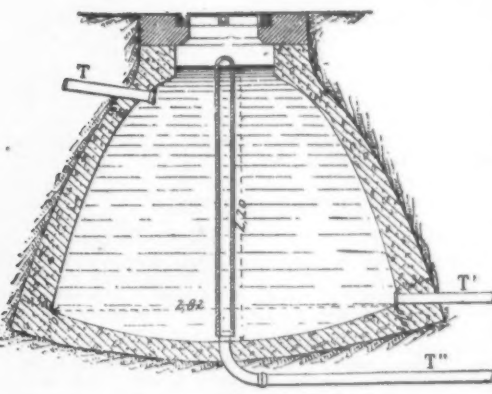
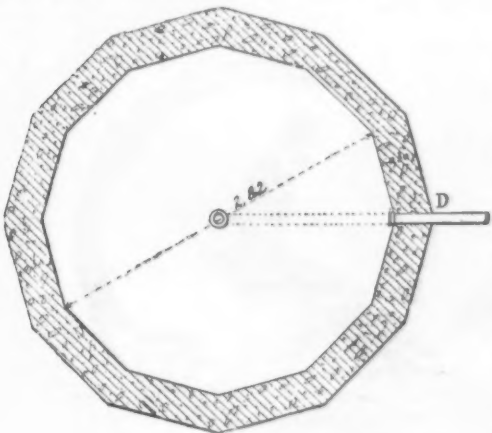
syringe, is then let down, the mud sucked up, lifted, and then the drill sent down to begin its pounding anew. Great deftness and experience are needed to work the drill without breaking the jars or connected machinery, and, in case of accident, there are grapples, hooks, knives, and other devices without number, to be used in recovering lost drills, cutting the rope, and other emergencies, the briefest explanation of which would exceed the limits of this letter.

The exciting moment in boring a well is when a drill is penetrating the upper covering of sand rock which overlies the oil. The force with which the compressed gas and petroleum rushes upward almost surpasses belief. Drill, jars, and sinker bar are sometimes shot out along with debris, oil, and hissing gas. Sometimes this gas and oil take fire, and last summer one of the wells thus ignited burned so fiercely that a number of days elapsed before the flames could be extinguished. More often the tankage provided is insufficient, and thousands of barrels escape. Two or three years ago, at the height of the oil production of the Bradford region, 8,000 barrels a day were thus running to waste. But those halcyon days of Bradford have gone forever. Although nineteen-twentieths of the wells sunk in this region "struck" oil and flowed freely, most of them now flow sluggishly or have to be "pumped" two or three times a week.

"Piping" and "casing," terms substantially identical, and meaning the lining of the well with iron pipe several inches in the interior diameter, complete the labor of boring. The well, if a good flowing one, does all the rest of the work itself, forcing the fluid into the local tanks, whence it is distributed into the tanks of the pipe-line companies, and is carried from them to the refineries. The pipe lines now reach from the oil regions to the seaboard, carrying the petroleum over hill and valley, hundreds of miles to tide-water.

A CEMENT RESERVOIR.

THE annexed figures represent, on a scale of 1 to 50, a plan and vertical section of a reservoir of beton, 11 cubic



A CEMENT RESERVOIR.

meters in capacity, designed for the storage of drinking water and for collecting the overflow of a canal. The volume of beton employed in its construction was 0.9 cubic meter per cubic meter of water to be stored. The inner walls were covered with a layer of cement to insure of tightness.

T is the inlet pipe, with a diameter of 0.08 m.

T' is the distributing pipe, and T'' is the waste pipe.—*Annales des Travaux Publics.*

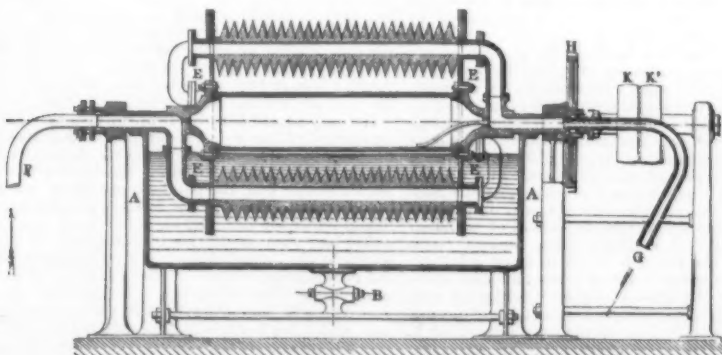


FIG. 1.—LONGITUDINAL SECTION.

PERRE & QUIDET'S EVAPORATING APPARATUS.

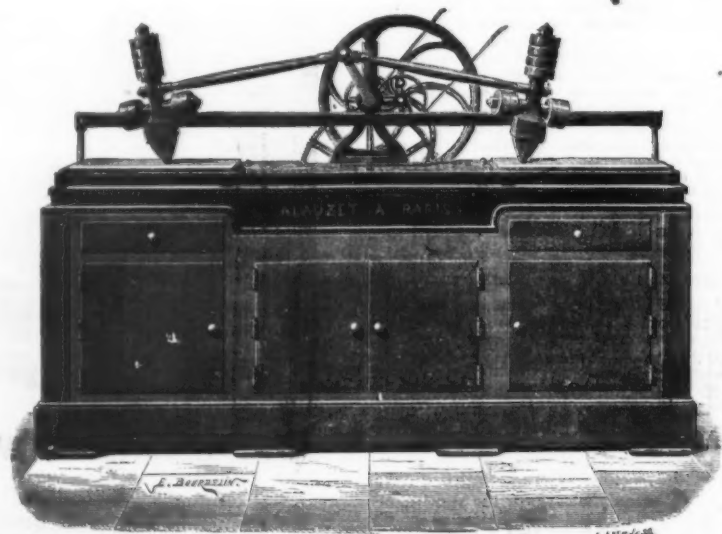
MACHINE FOR GRINDING LITHOGRAPHIC INKS AND COLORS.

THE grinding of the inks and colors that are employed in lithography is a long and delicate operation, which it has scarcely been possible up to the present time to perform satisfactorily otherwise than by hand, because of the perfect mixture that it is necessary to obtain in the materials employed.

Per contra, this manual work, while it has the advantage of giving a very homogeneous product, offers the inconvenience of taking a long time and being costly. The Alauzet machine, shown in the accompanying cut, is designed to perform this work mechanically.

The apparatus consists of a flat, cast iron, rectangular frame, resting upon a wooden base which forms a closet. In a longitudinal direction there is mounted on the machine a rectangular guide, along which travel two iron slides in the shape of a reversed U, which make part of two smaller carriers that are loaded with weights, and to which are fixed cast-steel mullers.

At the center of the frame there is fixed a support which carries a train of gear wheels which is set in motion by a pulley and belt. These wheels serve to communicate a backward and forward motion, longitudinally, to the mullers through the intermedium of a winch, and a backward and forward motion transversely to two granite tables on which is placed the ink or color to be ground. This last-named motion is effected by means of a bevel pinion which is keyed to the same axle as the large gear wheel, and which actuates a heart wheel—this latter being adjusted in a horizontal frame which is itself connected to the cast iron plate into which the tables are set.



ALAUZET'S MACHINE FOR GRINDING LITHOGRAPHIC INKS.

This machine, which is 2 meters in length by 1 meter in width, requires a one-third horse power to actuate it. It weighs altogether about 800 kilogrammes.—*Annales Industrielles.*

A NEW EVAPORATING APPARATUS.

At a recent meeting of the *Société Industrielle* of Elbeuf, Mr. L. Quidet described an apparatus that he had, with the aid of Mr. Perré, invented for evaporating juices.

In this new apparatus a happy application is made of those pipes with radiating disks that have for some time been advantageously employed for heating purposes. In addition to this it is so constructed as to give the best of results as regards evaporation, thanks to the lengthy travel that the current of steam makes in it.

It may be seen from an examination of the annexed cuts, the apparatus consists essentially of a cylindrical reservoir, in the interior of which revolves a system formed of seven pipes, with radiating disks, affixed to plate iron disks, E E. The reservoir is mounted upon a cast-iron frame, and is provided at its lower part with a cock, B, which permits of the liquid being drawn off when it has been sufficiently concentrated. It is surmounted with a cover, which is bolted to lateral flanges, so that the two parts as a whole constitute a complete cylinder. This shape, however, is not essential, and the inventors reserve the right of giving it the arrangement that may be best adapted to the application that is to be made of it.

In the center of the apparatus there is a conduit whose diameter is greater than that of the pipes provided with radiators, and which serves to cross-brace the two ends, E E, which latter consist of iron boxes cast in a piece with the hollow shaft of the rotary system.

The steam enters through the pipe, F, traverses the first evaporating pipe, then the second, then the third, and so on, and continues to circulate in this manner till it finally reaches the last one, which communicates with the exit, G.

Motion is transmitted to the evaporator by a gearing, H, which is keyed on the shaft, and is actuated by a pinion, L, connected with an intermediate shaft which is provided with fast and loose pulleys.

The apparatus is very efficient in its action, and this is due, in the first place, to the use of radiators, which greatly increase the heating surface, and second, to the motion communicated to the evaporating parts. In fact, each of the pipes, on issuing from the liquid to be concentrated, carries upon its entire surface a pellicle which evaporates immediately.

The arrangement devised by Messrs. Perré and Quidet realizes, then, the best theoretic conditions for this sort of work, to wit:

1. A large evaporating surface.
2. A very slight thickness of liquid.
3. A constant temperature of about from 100° to 120°, according to the internal pressure of the steam.

Owing to such advantages, this apparatus will find an application in numerous industries, and will render them many services.—*Revue Industrielle.*

"FLYING."

To the Editor of the *Scientific American*:

Your correspondent on this subject in the issue of April 14 cites an array of facts from which it would seem the proper conclusions should be inferred. I think the whole difficulty arises from a confusion of terms, and by this I

mean a want of care to explain the unknown strictly in terms of the known; and I think underlying this error is a misconception as to what an animal is, and what animal strength is, only of course with reference to this particular discussion, *i. e.*, in so far only as they may be considered physical organisms having no reference to the intellectual or moral development, all of which lies beyond the sphere of our discussion.

Purely with reference to the development of physical strength, which alone is under consideration, any animal organism whatsoever must be considered simply in the light of a machine.

A compound machine having two parts, first an arrangement of levers and points of application of power, all of which is purely mechanical, together with an arrangement of parts, designed, first, to convert fuel or food into heat, and, secondly, to transform heat into force, which is purely a chemical change in the first instance, and a transformation of energy in the second. So much for the animal—man or beast—as a machine physically considered.

What then is animal strength considered in the same light? The animal is not creative. It can make nothing—it can only transform. Does it create any strength or force? No. The strength it puts forth or exerts is merely the outcome of this transformation, which it is the office of the machine to perform.

What do we find transformed? Simply the energy, or potential, contained in the fuel or food we put into the machine. Its exact equivalent we find transformed to another

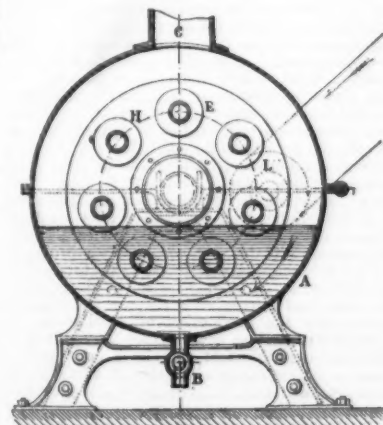


FIG. 2.—TRANSVERSE SECTION.

form of energy, known as animal strength, which is simply heat within the system available for the working of its mechanical parts. How, then, is this energy which exists in the shape of animal strength used and distributed? This is the question the answer of which underlies this whole discussion as a principle. It is distributed to the different parts of the machine in proportion to the relative amount of physical work that nature has made it the office of any particular part to perform.

Let us see how it is with the bird machine. In course of flight he is called upon to remain in the air, which means that should he cease to make an effort to do this, *i. e.*, should he cease to expend energy in doing it, he would fall during the first second of time after ceasing to make the effort some sixteen feet toward the center of the earth. But he remains in the air for hours and days at a time. What is he, then, doing every second of that time? He is overcoming the force of gravitation, which is incessantly pulling him down. That is, every second he is doing an amount of work equal to his weight—say 10 lb. multiplied by 16—say 160 lb. approximately; all this by beating the air with his wings. Now let us institute a slight comparison—and the work shall be performed by a man, who climbs a mountain 10,000 feet high in 10 hours. The man weighs 150 lb.; he climbs 10,000 feet; 1,500,000 foot pounds is, then, the work done. He does it in 10 hours, or 36,000 seconds, which gives an amount of work of only 42 foot pounds per second performed by his muscles of locomotion.

At the end of the ten hours the man is exhausted, while the bird delights in further flight. To what is this difference of condition due? It is due simply to the difference in the machine; but this, you say, is not explaining the unknown in terms of the known. Let us see, then, if we cannot do this. In the two accounts of work done as above cited in the case of the man and the bird, an amount of energy, *i. e.*, heat of the system, has been expended just proportional to the work done.

Now while the bird has expended more energy in this particular work of locomotion than has the man, we find the bird machine has done little else; he has consumed but little of his available heat force in exercising his brain or the other functions of his system, or in preserving the temperature of the body, and but little of his animal heat, which is his strength, has been radiated into space. In short, we find the bird machine so devised by nature that a very large proportion of the available energy of the system can be used in working those parts contrived for locomotion, and resist the force of gravity, or, what is the same thing, nature has placed a greater relative portion of the whole furnace at the disposal of these parts than she has in man. The breast muscles of the bird are so constructed as to burn a far greater proportional amount of the fuel from which all energy is derived than do the muscles of the rest of the body combined.

Let us see how it is with the man who has climbed the mountain. In this machine we find affairs in a very different state. During his climbing he has been doing a vast amount of other work, both internal and external. His arms, his whole muscular system, in fact, has been vigorously at work, all drawing upon his total available energy. His brain has been in constant and unremitting action, as well as the other internal organs, which require a greater proportional amount of energy than they did in the bird. Besides this, he has been radiating his animal heat into space in a far greater amount. All these parts must be supplied; they cannot be neglected while the accumulated surplus is given to the machinery for locomotion or lifting. This then is what constitutes what I call the difference in the machine, which is purely one of organic development depending upon the functions nature has determined that the different organs shall perform. As for the pterodactyl quoted in the last article, I have only to remark that this discussion arose purely from a consideration of what was the best type of flying apparatus nature had given man to study, and I claim that this prehistoric bird of geology does not come within this class. For if it is not fully established that this species had become extinct long before the appearance of man on the globe, it is at least certain that the man of that early day had not dreamt of flying and was presumably content if he could find other means to evade the pterodactyl's claw.

F. J. P., U. S. Army.

THE PORTRUSH ELECTRIC RAILWAY, IRELAND.*

By DR. EDWARD HOPKINSON.

In the summer of 1881, Mr. W. A. Traill, late of H. M. Geological Survey, suggested to Dr. Siemens that the line between Portrush and Bushmills, for which Parliamentary powers had been obtained, would be suitable in many respects for electrical working, especially as there was abundant water power available in the neighborhood. Dr. Siemens at once joined in the undertaking, which has been carried out under his direction. The line extends from Portrush, the terminus of the Belfast and Northern Counties Railway, to Bushmills in the Bush valley, a distance of six miles. For about half a mile the line passes down the principal street of Portrush, and has an extension along the Northern Counties Railway to the harbor. For the rest of the distance, the rails are laid on the sea side of the county road, and the head of the rails being level with the ground, a footpath is formed the whole distance, separated from the road by a curbstone. The line is single, and has a gauge of three feet, the standard of the existing narrow gauge lines in Ulster. The gradients are exceedingly heavy, as will be seen from the diagram, being in parts as steep as 1 in 35. The curves are also in many cases very sharp, having necessarily to follow the existing road. There are five passing places, in addition to the sidings at the terminus and at the carriage depot. At the Bushmills end, the line is laid for about 200 yards along the street, and ends in the market-place of the town. It is intended to connect it with an electrical railway from Dervock, for which Parliamentary powers have already been obtained, thus completing the connection with the narrow gauge system from Ballymena to Larne and Cushendall. About 1,500 yards from the end of the line, there is a waterfall on the river Bush, with an available head of 24 feet, and an abundant supply of water at all seasons of the year. Turbines are now being erected, and the necessary works executed for employing the fall for working the generating dynamo machines, and the current will be conveyed by means of an underground cable to the end of the line. Of the application of the water power it is unnecessary to speak further, as the works are not yet com-

pleted. For the present, the line is worked by a small steam-engine placed at the carriage depot at the Portrush end. The whole of the constructive works have been designed and carried out by Mr. Traill, assisted by Mr. E. B. Price.

The system employed may be described as that of the separate conductor. A rail of T-iron, weighing 19 pounds to the yard, is carried on wooden posts, holed in pitch, and placed ten feet apart, at a distance of 23 inches from the inside rail and 17 inches above the ground. This rail comes close up against the fence on the side of the road, thus forming an additional protection. The conductor is connected by an underground cable to a single shunt-wound dynamo machine, placed in the engine shed, and worked by a small agricultural steam engine of about 25 indicated horse power. The current is conveyed from the conductor by means of two springs, made of steel, rigidly held by two steel bars placed one at each end of the car, and projecting about six inches from the side. Since the conducting rail is iron, while the brushes are steel, the wear of the latter is exceedingly small. In dry weather they require the rail to be slightly lubricated; in wet weather they require the water on the surface of the iron provides all the lubrication required. The double brushes, placed at the extremities of the car, enable it to bridge over the numerous gaps, which necessarily interrupt the conductor to allow cart ways into the fields and commons adjoining the shore. On the diagram the car is shown passing one of these gaps: the front brush has broken contact, but since the back brush is still touching the rail, the current has not been broken. Before the back brush leaves the conductor, the front brush will have again risen upon it, so that the current is never interrupted. There are two or three gaps too broad to be bridged in this way. In these cases the driver will break the current before reaching the gap, the momentum of the car carrying it the 10 or 12 yards it must travel without power.

The current is conveyed under the gaps by means of an insulated copper cable carried in wrought-iron pipes, placed at a depth of 18 inches. At the passing places, which are situated on inclines, the conductor takes the inside, and the car ascending the hill also runs on the inside, while the car descending the hill proceeds by gravity on the outside lines.

From the brushes the current is taken to a commutator worked by a lever, which switches resistance frames placed under the car, in or out, as may be desired. The same lever alters the position of the brushes on the commutator of the dynamo machine, reversing the direction of rotation, in the manner shown by the electrical hoist. The current is not, as it were, turned full on suddenly, but passes through the resistances, which are afterward cut out in part or altogether, according as the driver desires to run at part speed or full speed.

From the dynamo the current is conveyed through the axle boxes to the axles, thence to the tires of the wheels, and finally back by the rails, which are uninsulated, to the generating machine. The conductor is laid in lengths of about 21 feet, the lengths being connected by fish plates and also by a double copper loop securely soldered to the iron. It is also necessary that the rails of the permanent way should be connected in a similar manner, as the ordinary fish plates give a very uncertain electrical contact, and the earth for large currents is altogether untrustworthy as a conductor, though no doubt materially reducing the total resistance of the circuit.

The dynamo is placed in the center of the car, beneath the floor, and through intermediate spur gear drives by a steel chain on to one axle only. The reversing levers, and also the levers working the mechanical brakes, are connected to both ends of the car, so that the driver can always stand at the front and have uninterrupted view of the rails, which is of course essential in the case of a line laid by the side of the public road.

The cars are first and third class, some open and some covered, and are constructed to hold twenty people, exclusive of the driver. At present, only one is fitted with a dynamo, but four more machines are now being constructed by Messrs. Siemens Bros., so that before the beginning of the heavy summer traffic five cars will be ready; and since two of these will be fitted with machines capable of drawing a second car, there will be an available rolling stock of seven cars. It is not intended at present to work electrically the portion of the line in the town at Portrush, though this will probably be done hereafter; and a portion, at least, of the mineral traffic will be left for the two steam-tramway engines which were obtained for the temporary working of the line pending the completion of the electrical arrangements.

Let us now put in a form suitable for calculation the principles with which Mr. Siemens has illustrated in a graphic form more convenient for the purposes of explanation, and then show how these principles have been applied in the present case.

Let L be the couple, measured in foot-pounds, which the dynamo must exert in order to drive the car, and ω the necessary angular velocity. Taking the tare of the car as 50 cwt., including the weight of the machinery it carries, and a load of twenty people as 30 cwt., we have a gross weight of 4 tons. Assume that the maximum required is that the car should carry this load at a speed of seven miles an hour, on an incline of 1 in 40. The resistance due to gravity may be taken as 56 lb. per ton, and the frictional resistance and that due to other causes, say, 14 lb. per ton, giving a total resistance of 280 lb., at a radius of 14 inches. The angular velocity of the axle corresponding to a speed of seven miles an hour, is 84 revolutions per minute. Hence $L = 327$ foot pounds, and $\omega = \frac{2\pi \times 84}{60}$.

If the dynamo be wound directly on the axle, it must be designed to exert the couple, L , corresponding to the maximum load, when revolving at an angular velocity, ω , the difference of potential between the terminals being the available E.M.F. of the conductor, and the current the maximum the armature will safely stand. This will be the case in the Charing-cross Electrical Railway. But when the dynamo is connected by intermediate gear to the driving wheels only, the product of L and ω remains constant, and the two factors may be varied. In the present case L is diminished in the ratio of 7 to 1, and ω consequently increased in the same ratio. Hence the dynamo, with its maximum load, must revolve at 588 revolutions per minute, and exert a couple of forty-seven foot-pounds. Let E be the potential of the conductor from which the current is drawn, measured in volts, C the current in amperes, and E_1 the E.M.F. of the dynamo. Then E_1 is proportional to the product of the angular velocity, and a certain function of the current. For a velocity Ω , let this function be denoted by $f(C)$. If the characteristic of the dynamo can be drawn, then $f(C)$ is known.

We have then

$$E_1 = \frac{\omega}{\Omega} f(C) \quad (1.)$$

If R be the resistance in circuit by Ohm's law,

$$C = \frac{E - E_1}{R} \\ = E - \frac{\omega}{\Omega} f(C)$$

and therefore

$$\omega = \frac{R(E - C R)}{f(C)} \quad (2.)$$

Let α be the efficiency with which the motor transforms electrical into mechanical energy, then—

$$\text{Power required} = L \omega = \alpha E_1 C \\ = \alpha C \frac{\omega}{\Omega} f(C)$$

Dividing by ω ,

$$L = \frac{\alpha C f(C)}{\Omega} \quad (3.)$$

It must be noted that L is here measured in electrical measure, or, adopting the unit given by Dr. Siemens in the British Association Address, in joules. One joule equals approximately 0.74 foot-pound. Equation 3 gives at once an analytical proof of the second principle stated above, that for a given motor the current depends upon the couple, and upon it alone. Equation 2 shows that with a given load the speed depends upon E , the electromotive force of the main, and R the resistance in circuit. It shows also the effect of putting into the circuit the resistance frames placed beneath the car. If R be increased, until CR is equal to E , then ω vanishes, and the car remains at rest. If R be still further increased, Ohm's law applies, and the current diminishes. Hence suitable resistances are, first, a high resistance for diminishing the current, and consequently, the sparking at making and breaking of the circuit; and, secondly, one or more low resistances for varying the speed of the car. If the form of $f(C)$ be known, as is the case with a Siemens machine, equations 2 and 3 can be completely solved for ω and C , giving the current and speed in terms of L , E , and R . The expressions so obtained are not without interest, and agree with the results of experiment.

It may be observed that an arc light presents the converse case to a motor. The E.M.F. of the arc is approximately constant, whatever the intensity of the current passing between the carbons; and the current depends entirely on the resistance in circuit. Hence the instability of an arc produced by machines of low internal resistance, unless compensated by considerable resistance in the leads.

The following experiment shows in a striking form the principles just considered: An Edison lamp is placed in parallel circuit with a small dynamo machine, used as a motor. The Prony brake on the pulley of the dynamo is quite slack, allowing it to revolve freely. Now let the lamp and dynamo be coupled to the generator running at full speed. First, the lamp glows, in a moment it again becomes dark, then, as the dynamo gets up speed, glows again. If the brake be screwed up tight, the lamp once more becomes dark. The explanation is simple. Owing to the coefficient of self-induction of the dynamo machine being considerable, it takes a finite time for the current to obtain an appreciable intensity, but the lamp having no self-induction, the current at once passes through it, and causes it to glow. Secondly, the electrical inertia of the dynamo being overcome, it must draw a large current to produce the kinetic energy of rotation, *i. e.*, to overcome its mechanical inertia; the lamp is therefore practically short-circuited, and ceases to glow. When once the rotation has been established, the current through the dynamo becomes very small, having no work to do except to overcome the friction of the bearings, hence the lamp again glows. Finally, by screwing up the brake, the current through the dynamo is increased, and the lamp again short-circuited.

It has often been pointed out that reversal of the motor on the car would be a most effective brake. This is certainly true; but, at the same time, it is a brake that should not be used except in cases of emergency. For this reason, the dynamo revolving at a high speed, the momentum of the current is very considerable; hence, owing to the self-induction of the machine, a sudden reversal will tend to break down the insulation at any weak point of the machine. The action is analogous to the spark produced by a Ruhmkorff coil. This was illustrated at Portrush; when the car was running perhaps fifteen miles an hour, the current was suddenly reversed. The car came to a standstill in little more than its own length, but at the expense of breaking down the insulation of one of the wires of the magnet coils. The way out of the difficulty is evidently at the moment of reversal to insert a high resistance to diminish the momentum of the current.

In determining the proper dimensions of a conductor for railway purposes, Sir William Thomson's law should properly apply. But on a line where the gradients and traffic are very irregular, it is difficult to estimate the average current, and the desirability of having the rail mechanically strong, and of such low resistance that the potential shall not vary very materially throughout its length, becomes more important than the economic considerations involved in Sir William Thomson's law. At Portrush the resistance of a mile, including the return by earth and the ground rails, is actually about 0.23 ohm. If calculated from the section of the iron, it would be 0.15 ohm, the difference being accounted for by the resistance of the copper loops, and occasional imperfect contacts. The E.M.F. at which the conductor is maintained is about 225 volts, which is well within the limit of perfect safety assigned by Sir William Thomson and Dr. Siemens. At the same time the shock received by touching the iron is sufficient to be unpleasant, and hence is some protection against the conductor being tampered with.

Consider a car requiring a given constant current; evidently the maximum loss due to resistance will occur when the car is at the middle point of the line, and will then be one-fourth of the total resistance of the line, provided the two extremities are maintained by the generators at the same potential. Again, by integration, the mean resistance can be shown to be one-sixth of the resistance of the line. Applying these figures, and assuming four cars are running, requiring

* A paper recently read before the Society of Arts, London.

4 horse power each, the loss due to resistance does not exceed 4 per cent. of the power developed on the cars; or if one car only be running, the loss is less than 1 per cent. But in actual practice at Portrush even these estimates are too high, as the generators are placed at the bottom of the hills, and the middle portion of the line is more or less level, hence the minimum current is required when the resistance is at its maximum value.

The insulation of the conductor has been a matter of considerable difficulty, chiefly on account of the moistness of the climate. An insulation has now, however, been obtained of from 500 to 1,000 ohms per mile, according to the state of the weather, by placing a cap of insulite between the wooden posts and T-iron. Hence the total leakage cannot exceed 2.5 amperes, representing a loss of three-fourths of a horse power, or under 5 per cent., when four cars are running. But apart from these figures, we have materials for an actual comparison of the cost of working the line by electricity and steam. The steam tramway engines, temporarily employed at Portrush, are made by Messrs. Wilkinson, of Wigan, and are generally considered as satisfactory as any of the various tramway engines. They have a pair of vertical cylinders, 8 inches diameter and one foot stroke, and work at a boiler pressure of 120 lb., the total weight of the engine being 7 tons. The electrical car with which the comparison is made has a dynamo weighing 13 cwt., and the tare of the car is 52 cwt. The steam-engines are capable of drawing a total load of about 12 tons up the hill, excluding the weight of the engine; the dynamo over six tons, including its own weight; hence, weight for weight, the dynamo will draw five times as much as the steam-engine. Finally, compare the following estimates of cost. From actual experience, the steam-engine, taking an average over a week, costs—

	£	s.	d.
Driver's wages.....	1	10	0
Cleaner's ".....	0	12	0
Coke, 58½ cwt. at 25s. per ton.....	3	18	1½
Oil, 1 gallon at 3s. 1d.....	0	3	1
Tallow, 4 lb. at 6d.....	0	2	0
Waste, 8 lb. at 2d.....	0	1	4
Depreciation, 15 per cent. on £750.....	2	3	3
Total.....	£8	4	9½

The distance run was 312 miles. Also, from actual experience, the electrical car, drawing a second behind it, and hence providing for the same number of passengers, consumed 18 lb. of coke per mile run. Hence, calculating the cost in the same way, for a distance run of 312 miles in a week—

	£	s.	d.
Wages of stoker of stationary engine....	1	0	0
Coke, 52 cwt. at 25s. per ton.....	2	15	0
Oil, 1 gallon at 3s. 1d.....	0	3	1
Waste, 4 lb. at 2d.....	0	0	8
Depreciation on stationary engine, 10 per cent. on £300 11s. 6d.	3	0	4
Depreciation of electrical apparatus, 15 per cent. on £500, £1 8s. 10d.			
Total.....	£5	19	1

A saving of over 25 per cent.

The total mileage run is very small, on account of the light traffic early in the year. Heavier traffic will tell very much in favor of the electric car, as the loss due to leakage will be a much smaller proportion of the total power developed.

It will be observed that the cost of the tramway engines is very much in excess of what is usual on other lines, but this is entirely accounted for by the high price of coke, and the exceedingly difficult nature of the line to work, on account of the curves and gradients. These causes send up the cost of electrical working in the same ratio, hence the comparison is valid as between the steam and electricity, but it would be unsafe to compare the cost of either with horse-traction or wire-rope traction on other lines. The same fuel was burnt in the stationary steam-engine and in the tramway engines, and the same rolling stock used in both cases; but, otherwise, the comparison was made under circumstances in favor of the tramway engine, as the stationary steam-engine is by no means economical, consuming at least 5 lb. of coke per horse-power hour, and the experiments were made, in the case of the electrical car, over a length of line three miles long, which included the worst hills and curves, and one-half of the conductor was not provided with the insulite caps, the leakage consequently being considerably larger than it will be eventually.

Finally, as regards the speed of the electrical car, it is capable of running on the level at the rate of 12 miles per hour, but as the line is technically a tramway, the Board of Trade Regulations do not allow the speed to exceed 10 miles an hour.

Taking these data as to cost, and remembering how this will be reduced when the water power is made available, and remembering such considerations as the freedom from smoke and steam, the diminished wear and tear of the permanent way, and the advantage of having each car independent, it may be said that there is a future for electrical railways.

We must not conclude without expressing our best thanks to Messrs. Siemens Bros. for having kindly placed all this apparatus at our disposal to-night, and allowing us to publish the results of experiments made at their works.

THE THOMSON-HOUSTON ELECTRIC LIGHTING SYSTEM.

The generator is known as the "Thomson spherical," on account of the nearly spherical form of its armature, and differs radically from all others in all essential portions, viz., its field magnets, armature, and winding thereof, and in its commutator; both in principle and construction, and, besides, it is provided with an automatic regulator, an attachment not applied to other generators. The annexed view of the complete machine will convey an idea of the general appearance and disposition of its parts.

The revolving armature which generates the electrical current is made internally of a hollow shell of soft iron secured to the central portion of the shaft between the bearings, and is wound externally with a copper conducting wire, constituting three coils or helices surrounding the armature, which coils are, however, permanently joined, and in reality act as a single three-branched wire.

This wire, being wound on the exterior of the armature, is fully exposed to the powerful magnetic influence of the field poles, which inclose the armature almost completely. The armature will thus be seen to be thoroughly incased and protected, at the same time that all the wire upon it is subject to a powerful action of the surrounding magnets, resulting in an economy in the generation of current in its

coils. The form of the armature being spherical, very little power is lost by air friction, and no injury can occur from increased speed developing centrifugal force. The field magnets, which surround the armature, are cast iron shells, wound outside with many convolutions of insulated copper wire, and are joined externally by iron bars to convey the magnetism. These outer bars serve also as a most efficient protection to the wire and armature of the machine during transportation or otherwise. Objects cannot fall upon or rest upon the wire coils and injure them. The coils of wire upon the field magnets surround not only the iron poles or shells, but are situated also so as to surround likewise the revolving armature, and increase the effect produced in it by direct induction and magnetism. This fea-

ture is not used in any other generator, nor does any other make use of a spherical armature. The shaft is mounted in babbitted bearings of ample size, sustained by a handsome frame therefor, and is of steel, finely turned and perfectly true. The shaft and armature together are balanced with the utmost care, and run without buzz or rumble. The armature wire is kept cool by an active circulation of air over its whole surface during revolution. The commutator, or portion from which the currents developed in the armature are carried out for use, is a beautiful piece of mechanism. It is mounted upon the end of the shaft, and has attached to it the wires, three only, coming from the armature wire through the tubular shaft.

The commutator is peculiar, consisting of only three segments of a copper ring, while in the simplest of other continuous current generators several times that number exist, and frequently 120! segments are to be found. These three segments are made so as to be removable in a moment for cleaning or replacement. They are mounted upon a metal support, and are surrounded on all sides by a free air space, and cannot, therefore, lose their insulated condition. This feature of air insulation is peculiar to this system, and is very important as a factor in the durability of the commutator. Besides this, the commutator is sustained by supports carried in flanges upon the shaft, which flanges, as an additional safeguard, are coated all over with hard rubber, one of the finest known insulators. It may be stated, without fear of contradiction, that no other commutator made is so thoroughly insulated and protected. The three commutator segments virtually constitute a single copper ring, mounted in free air, and cut into three equal pieces by slots across its face. Four slit copper springs, called commutator brushes or collectors, are allowed to bear lightly upon the commutator when it revolves, and serve to take up the current and convey it to the circuit. These commutator brushes are carried by movable supports, and their position is automatically regulated so as to control the strength of the developed current—a feature not found in other systems. This feature, as well as the fact that the commutator can be oiled to pre-

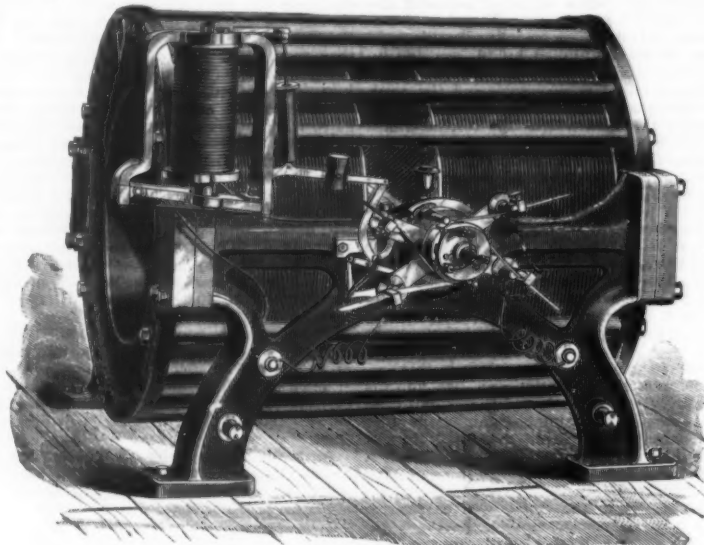
vent wear, saves attendance and greatly increases the durability of the wearing surfaces, while the commutator brushes are maintained in the position of best adjustment. The commutator and brushes, in consequence, after weeks of running, show scarcely any wear.

THE AUTOMATIC CURRENT REGULATOR.

This consists of a peculiar magnet attached to the frame of the generator, and the movable armature of which has connections to the supports of the commutator brushes for controlling their position. The regulator magnet is so formed as to give a uniform attraction upon its

armature in different positions. In Thomson's improved form this is accomplished in a novel manner by making the pole of the magnet paraboloidal in form, and making an opening in the movable armature to encircle said pole.

The armature is hung on pivots so as to be free to move only toward and from the regulating magnet on changes in the current traversing the latter, and being connected to the commutator brushes, automatically adjusts their position. By this means the power of the generator is adapted to run any number of lights within its limit of capacity, or may be short circuited purposely or by accident without difficulty arising therefrom; and a number of instances have occurred where the injurious effects of a short circuit accidentally formed have been entirely obviated by the presence of the



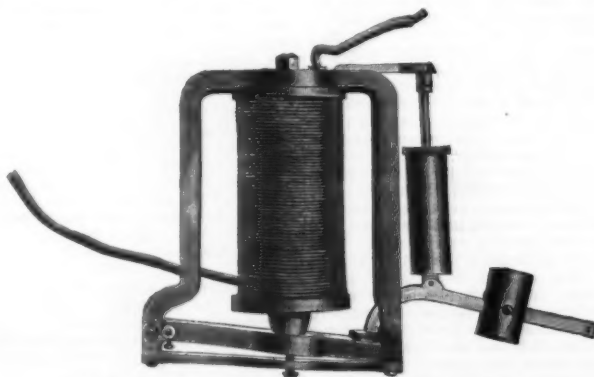
THE THOMSON SPHERICAL.

regulator. In one instance four generators, in series representing over forty lights' capacity, were accidentally short circuited, and no injury or even noticeable action took place except a quick movement of the regulators in adapting themselves to the new conditions. Had this accident occurred to generators unprovided with regulators, great injury or possible destruction of the apparatus would have resulted. It is important to a full understanding of the regulation, to



THE CONTROLLER MAGNET.

state that its action is independent of resistances introduced, that it saves power and carbons in proportion to lights extinguished, and that it compensates for speed variations above the minimum speed. The manner of its action is to control the generation of current at the source in the armature, and it does so by combining certain electrical actions so as to obtain a differential effect, such that when small



THE CURRENT REGULATOR.

force of current only is required it alone is furnished, and when the maximum force is needed the same shall be forthcoming.

On the larger generators we combine with the regulator magnet above described an exceedingly sensitive controller magnet governing the regulation, and by whose accuracy the smallest variations of current are counteracted, and the operation of the generator rendered perfect. The controller magnet is contained in a box placed on the wall or other support near the generator, and consists of a delicate double axial magnet controlling the admission of current to the regulator, upon the generator, and its action is exceedingly

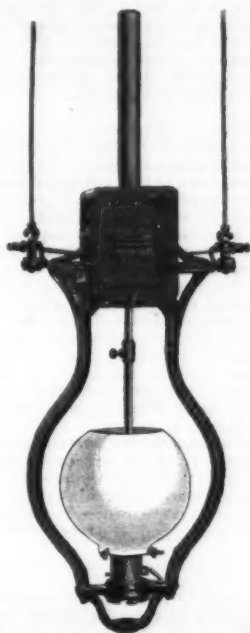
simple and effective. So perfect is the action that in a circuit of twenty-five to thirty lights, lights may be removed or put out in rapid succession without apparently affecting those that remain. Besides, we have been enabled to put out even eight or ten lights together instantly, while the remainder burn as before. The features above set forth are peculiar to the Thomson-Houston system, and have been thoroughly covered by patents, and cannot therefore be adopted into other systems.

THE THOMSON ARC LAMP.

This lamp is essentially a series lamp; that is, any number of them can be put on one circuit wire, but a single lamp, used alone, burns equally well. It consists of a metal frame supporting at the bottom the holder for the globe and lower carbon, which is insulated from the frame.

The annexed figure of the plain lamp will convey an understanding of its general appearance. The upper carbon is fed downward by the mechanism contained in the box above, and is carried by a vertical round rod called the carbon holding rod.

In the regulating box of the lamp there exists a simple mechanism, the result of careful study and experiment to discover the best and simplest combination of appliances, which would obviate the necessity for the use of clock-work or dash-pots, from which fluids might be accidentally spilled, for obtaining a gradual feeding of the carbon as fast as it is consumed in producing the light, and at the



THE THOMSON ARC LAMP.

same time to maintain the arc or space between the carbons in burning, of such extent as to give a steady, noiseless light, of greatest possible economy.

The lamp, once adjusted, does not require any readjustment, and, in fact, is built in such a manner as to avoid the presence of adjusting devices in it. The lamp also contains an automatic safety device for preserving the continuity of the circuit in case of accidental injury to the feeding mechanism or the carbons of the lamps. This is quite important when a considerable number of lights are operated upon one circuit wire, as a break in the circuit, due to a defective lamp, would result in the extinguishment of all the lights. With the safety device mentioned, such a break does not occur, but the flow of current is preserved through the faulty lamp.

By an exceedingly simple device upon the carbon holding rod, the lamps are extinguished when the carbons are burned out, and injury by burning the holders completely avoided.

The system is based upon the joint inventions of Elihu Thomson and Edwin J. Houston, for generators, regulators, and electric lamps, and also the patents of Elihu Thomson, in generators, regulators, and electric lamps; all of which are now operated and controlled by the Thomson-Houston Electric Co., 131 Devonshire Street, Boston, Mass.

A MODIFICATION OF THE VIBRATING BELL.

ONE of the causes which gives rise to induction in the telephone lines running along the Belgian railroads is that there are so many electric bells in the stations.

Mr. Lippens proposes as a remedy for the trouble a slight modification of the vibrating bell of his invention so as to exclude from the line the extra currents from the bell.

In one of the styles (Fig. 1) a spring, R, is attached at T to a fixed metallic rod, and presses against the rod, T'. The current enters through the terminal, B, traverses the bobbin, passes through T, through the spring, through T', and makes its exit through the other terminal. The armature is attracted, and the point, P, fixed thereto draws back the spring from the rod, T', and interrupts the current; but, at the moment at which the point touches the spring, and before the latter has been detached from the rod, T', the electro-magnet becomes included in a short circuit, and the line current, instead of passing through the bobbin for a very short time, passes through the wire, T, the armature, and the rod, T', so that the extra current is no longer sent into the line.

In another style (Fig. 2) the current is not interrupted at all, but enters through the terminal, B, traverses the bobbin, and goes through C to the terminal, B.

As soon as the armature is attracted, the spring, R, which is fixed to it presses against the fixed metallic rod, T, and thus gives the electricity a shorter travel than it would take by preference. The current ceases, then, to pass through the bobbin, demagnetization occurs, and the spring that holds the armature separates anew. The current now passes for a second time into the bobbin and produces a new action, and so on. There is no longer, then, any interruption of the current, and the motions of the hammer are

brought about by the change in direction of the current, which alternately traverses and leaves the bobbin.

In a communication that he has addressed to us on the subject of these bells, Mr. Lippens adds a few details in regard to the mode of applying the ground pile to micro-telephone stations.

Being given any two stations, he puts into the ground at the first a copper plate, and at the second a zinc one, and connects the two by a line wire provided with two vibrating bells and two telephone apparatus. The earth current

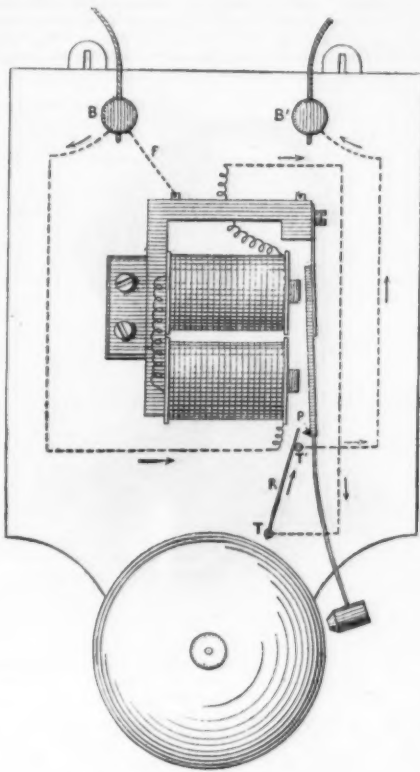


FIG. 1.

suffices to actuate the bells, but, in order to effect a call, the inventor is obliged to run them continuously and to interrupt them at the moment at which he wishes to communicate. The correspondent is then notified through the cessation of noise in the bells, and the two call-apparatus are thrown out of the circuit by the play of the commutator, and are replaced by the micro-telephone apparatus.

It is certainly impracticable to allow vibrating bells to ring continuously in this manner. The ground pile would,

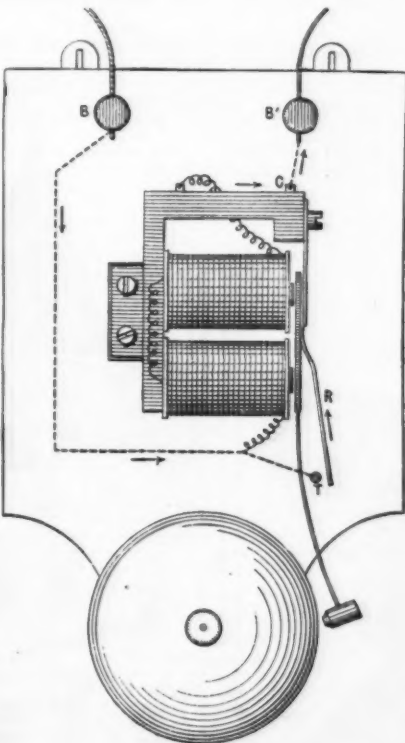


FIG. 2.

at the most, be only admissible in cases where the call, having to be made from only one of the stations, might be effected by a closing of the circuit.—*La Lumière Electrique*.

THE advantage of lighting vessels by electricity was shown when the steamer Carolina, of the old Bay Line between Baltimore and Norfolk, ran into the British steamship Riversdale in a dense fog off Cedar Point, on Chesapeake Bay. The electric lights of the Carolina were extinguished only in the damaged part of the boat, and her officers think that if she had been lighted in any other way, a conflagration would have followed the collision.

PHOTO PLATES—WET AND DRY.

DR. EDER has recently published, in the *Correspondenz*, the first of a series of articles embodying the results of his more recent work on gelatino bromide; and we now reproduce the substance of the article in a somewhat abstracted form.

The "sensitiveness of a wet" plate continues to be used as a rough and ready standard of comparison; and, notwithstanding the fact that it is physically impossible to exactly compare the sensitiveness of a wet plate with that of a gelatino bromide film, it is convenient to refer to wet plates as some kind of a rough standard.

Experiments have shown that a gelatino plate which gives the number 10 on the Warnerke sensitometer, may be regarded as approximately corresponding to the average wet plate; and setting out from this point, the following table has been constructed:

Sensitometer number.	Sensitiveness, expressed in terms of a "Wet Plate."
10	1
11	1 1/2
12	2
13	2 1/2
14	3
15	4
16	5
17	7
18	9
19	12
20	16
21	21
22	27
23	36
24	48
25	63

The nature of the developer used has, of course, some influence on the sensitiveness of the plates; but in the above cases it is assumed that oxalate developer, without any addition, is used; or pyro., to which ammonia is added at intervals of about thirty seconds, so as to produce a slight tendency to fog; the time of development being from three to four minutes. The numbers are supposed to be read after fixation, the plate being held against the sky.

Schumann's statement that a gelatino bromide plate is less sensitive when developed at 30° C. than when developed at 5°, is contested; the more recent investigations of Dr. Eder serving to demonstrate that a developer at a moderate high temperature acts very much more rapidly than when the temperature is low; but when a sufficient time is allowed for each developer to thoroughly penetrate the film, the difference becomes less apparent. Here are examples:

A.—Oxalate Developer.

Temperature of developer 4–8° C. 16–17° C. 26–28° C.

Time of development 1 min. ... 3" W. ... 8" W. ... 13" W.

" " 2 min. ... 9 1/2" W. ... 10" W. ... 15" W.

B.—Pyrogallie Developer.

Temperature of developer ... 1–2° C. 26–28° C.

Time of development 1/4 min. ... 0" W. 10" W.

" " 3 min. ... 14" W. 15" W.

INTENSIFIER FOR WET PLATES.

By MAJOR WATERHOUSE.

THE collodion process is still preferred for reproducing black and white designs, drawings, engravings, etc., where very dense negatives are desirable. The fixed and washed plate is put in a bath of bromide of copper (ten per cent. solution); the film whitens immediately, and when the color is even all over, the plate is taken out and plunged into a bath of the ordinary ferrous oxalate developer. It takes a dark olive tint, which is very non-actinic, the shadows meanwhile remaining very clear.—*Photo. News*.

GELATINO BROMIDE EMULSION WITH BROMIDE OF ZINC.

BY this time of the year I have no doubt many, both amateur and professional photographers, are either contemplating or are actually at work making their stock of plates for the coming season, and it is to be hoped that we shall have more favorable weather than we had last year.

Some four or five years since I tried using bromide of zinc instead of the ordinary salts, namely, bromide of ammonium or potassium. I only made one batch of plates at the time, which possessed several important features I considered an advantage, and I think well worth while following out. I do not think it can be denied that ordinary gelatino plates, if exposed in a weak light, fall very short of the results obtained with wet collodion when compared side by side, gelatino being almost useless under these conditions, and there is a decided gain in the result in this respect if the emulsion be made with zinc bromide.

In using bromide of zinc there is a slight difficulty to overcome, but it can be overcome, as I have succeeded in making a perfect emulsion. It will, I have no doubt, be remembered that Mr. L. Warnerke was the first to call attention to this salt in the days of collodion emulsion; and I think he claimed for an emulsion prepared with it that the image would stand more forcing without fogging to gain any amount of intensity. This was said of a collodion emulsion, and I also find that it is the same when used in a gelatino emulsion. I have heard a great many say, when speaking about the intensity of gelatino plates, that they can get any amount of intensity. I grant that in a studio where the operator has full command over the lighting of his subject by means of blinds, but it is not so in the field, especially when the light is dull. I have seen thousands of negatives, and as a rule I have found want of intensity has been the fault, and generally through the light. Now if we can find a remedy for this, it will be a step in advance.

What I claim for bromide of zinc is that a rapid plate can be made with it, and any degree of intensity can be readily obtained with a very small proportion of pyrogallie acid in the developer. The cry is always is to use plenty of pyrogallie acid and you can get any amount of intensity. I remember, in the early days of gelatino, as much as six grains being recommended, and I have myself, under extraordinary circumstances, used as much as ten grains to the ounce; but I think it is now, to a certain extent, a thing of the past. With the plates to which I refer, I found that I only required to use for a 7 1/2 x 5 plate one grain of pyrogallie acid in about three ounces of developer to get full density without the slightest difficulty. If the ordinary quantity were used far too much density was obtained, and the plate ruined beyond recovery; but with so small a quantity of pyro. the

plate was not so much stained as with a larger quantity, and the negative took far less time to develop on account of the intensity being so readily obtained.

In making a gelatine emulsion with zinc it must be *decidedly acid* or it fogs. I prefer nitric acid for the purpose. I also found that some samples of the bromide behaved in a very peculiar way. All went on well until it came to the washing, when the bromide of silver washed out slowly, rendering the washing water slightly milky; this continued until the whole of the bromide of silver was discharged from the gelatine, and the latter rendered perfectly transparent as in the first instance. I remember a gentleman mentioning at one of the meetings of the South London Photographic Society that he was troubled in the same way as I was at that time. I think if a few experiments were made in this direction with the zinc salt and worked out, it would be a great advantage.—*Wm. Brooks, in Br. Jour. of Photo.*

DESIGN FOR A VILLA.

THE villa of which we give a perspective drawing is intended as a country residence, being designed in a quiet and picturesque style of domestic Gothic, frequently met with in old country houses. It is proposed to face the external walls with red Suffolk bricks and Corsham Down stone dressings, the chimneys to be finished with moulded bricks. The attic gables, etc., would be half-timbered in oak, and the roof covered with red Fareham tiles laid on felt. Internally, the hall and corridors are to be laid with tiles; the wood finishing on ground floor to be of walnut, and on first floor of pitch pine. The ground floor contains drawing-room, 23 ft. by 16 ft., with octagonal recess in angle (which also forms a feature in the elevation), and door leading to conservatory. The morning-room, 16 ft. by 16 ft., also leads into conservatory. Dining-room, 20 ft. by 16 ft., with serving door leading from kitchen. The hall and principal staircase are conveniently situated in the main part of the house, with doors leading to the several rooms, and entrances to garden. The domestic offices, though conveniently placed, are entirely cut off from the main portion of the house by a door leading from the hall. In the basement there is ample cellar accommodation for wine or other purposes. The first floor contains four bed-rooms, two dressing-rooms, bath-room, w. c., etc. The attic floor, reached by the servants' staircase, contains two servants' bed-rooms, day and night nurseries, and box and store rooms. The estimated cost is £3,800. The design is by Mr. Charles C. Bradley, of 82 Wellesley Road, Croydon.—*Building Times.*

WILLIAM SPOTTISWOODE.

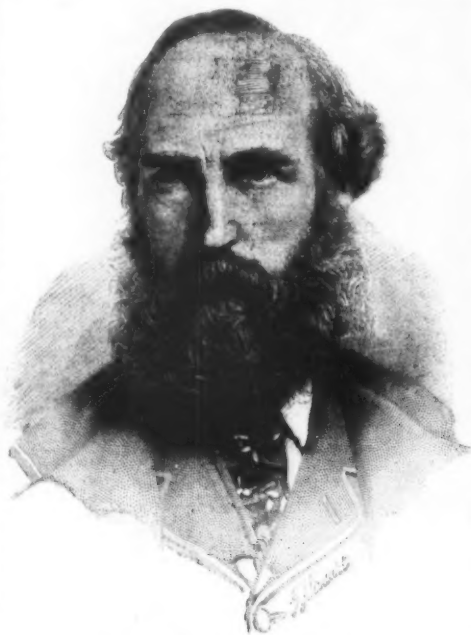
WILLIAM SPOTTISWOODE, President of the Royal Society, was born in London, Jan. 11, 1825. He belongs to an ancient Scottish family, many members of which have risen to distinction in Scotland and also in the New World.

In 1845 he took a first class in mathematics, and he afterward won the junior (1846) and the senior (1847) university mathematical scholarships. He returned to Oxford for a term or two, and gave a course of lectures in Balliol College on Geometry of Three Dimensions—a favorite subject of his. He was examiner in the mathematical schools in 1857–58. On leaving Oxford, he immediately, we believe, took an active part in the working management of the business of the Queen's printers, about this time resigned to him by his father, Andrew Spottiswoode, brother of the Laird of Spottiswoode. The business has largely developed under his hands.

Other subjects than mathematics have occupied his attention: at an early age he studied languages, as well Oriental as European.

As treasurer and president, he has been continuously on

the Council of the Royal Society for a great many years, and through his exceptional gifts as an administrator he has rendered it invaluable services. He has rendered similar services to the British Association, to the London Mathematical Society, and to the Royal Institution. We have permission to make the following extract from a letter written by a friend of many years' standing: "In the councils (of the various societies) he has always been distinguished by his sound judgment and his deep sympathy with their purest and highest aims. There never was a trace of partisanship in his action, or of narrowness in his sympathies. On the contrary, every one engaged in thoroughly scientific work has felt that he had a warm supporter in Spottiswoode, on whose opportune aid he might surely count. The same breadth of sympathy and generosity of sentiment has marked also his relations to those more entirely dependent upon him.



WILLIAM SPOTTISWOODE.

The workmen in his large establishment all feel that they have in him a true and trustworthy friend. He has always identified himself with their educational and social well-being." We give here a list of some of the offices Mr. Spottiswoode has held, and of the honors that have been bestowed upon him: Treasurer of the British Association from 1861 to 1874, of the Royal Institution from 1865 to 1873, and of the Royal Society from 1871 to 1878. In 1871 he succeeded Dr. Benze Jones as Honorary Secretary to the Royal Institution. President of Section A, 1865; of the British Association, 1878; of the London Mathematical Society, 1870 to 1872; of the Royal Society, 1879, which office he still holds. Correspondent of the Institut (Academie des Sciences), March 27, 1876. He is also LL.D. of the Universities of

Cambridge, Dublin, and Edinburgh, D.C.L. of Oxford, and F.R.A.S., F.R.G.S., F.R.S.E. In addition to these honors he has many other literary and scientific distinctions.—*Nature.*

ACETATE OF LIME.

I HAVE made a series of experiments with regard to finding a reliable method of estimating the acetic acid in commercial acetate of lime, and find the following gives the best results: The sample is finely ground and about 6 grms. weighed into a half-liter flask, dissolved in water, and diluted to the containing mark. 100 c. c. of this solution are distilled with 70 grms. of strong phosphoric acid nearly to dryness, and 50 c. c. of water are added to the residue in the retort and distilled till the distillate gives no precipitate with nitrate of silver, titrate the distillates with standard caustic soda, evaporate to dryness in a platinum dish, and ignite the residue before the blow pipe, which converts the phosphate of soda (formed by a little phosphoric acid carried over in the distillation) into the insoluble pyrophosphate and the acetate of soda into NaHO; dissolve in water, and titrate with standard H₂SO₄, which gives the amount of soda combined with the acetic acid in the original sample. In a number of samples analyzed they were found to vary hardly anything.—*C. H. Staylor, in Chem. News.*

THE REMOVAL OF AMMONIA FROM CRUDE GAS.

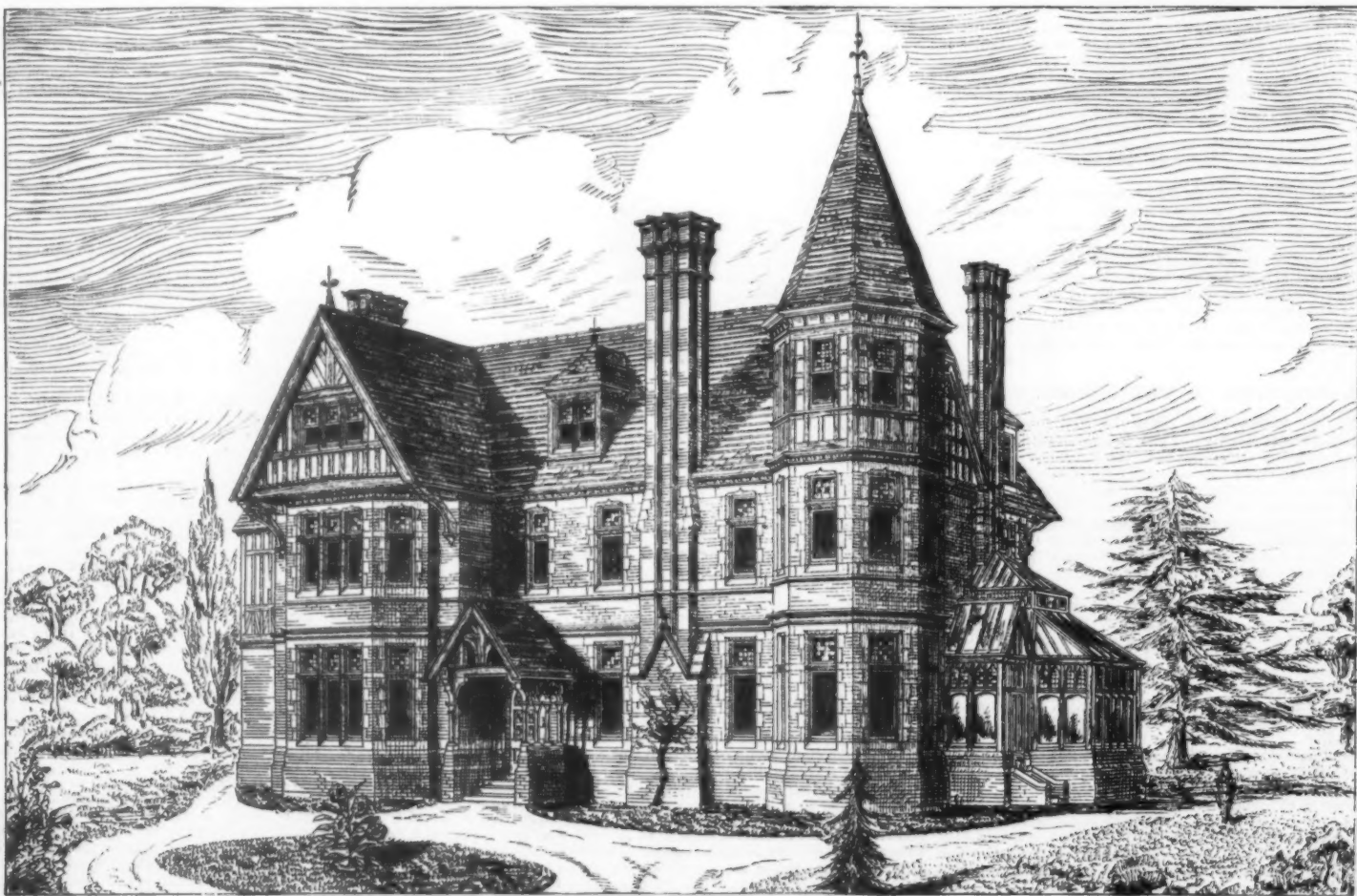
In connection with the many plans now brought forward to utilize the ammonia in the gases escaping from coke ovens and blast furnaces, it may be of interest to refer to a process brought out some years ago in connection with illuminating gas manufacture by Messrs. Bolton & Wanklyn, and adapted by them, we understand, to the metallurgical branches also.

When bone ash or any other substance containing phosphate of lime is treated with sulphuric acid, the products formed are superphosphate of lime and hydrated sulphate of lime; this mixture is known as superphosphate of lime, in commerce, and is the substance used in this process. This substance is capable of absorbing carbonic acid and ammonia from foul gas. The complete action can only take place in the presence of a certain proportion of carbonic acid, so that the process is not so successful with "well-scrubbed illuminating gas." The superphosphate is converted into carbonate of lime, while the ammonia combines with the phosphoric acid to form phosphate of ammonia; the hydrated sulphate of lime is also acted upon, and forms carbonate of lime and sulphate of ammonia; so that, presuming the action to be complete, and the material to be thoroughly saturated with carbonic acid and ammonia from the foul gas, the result is a mixture of carbonate of lime and phosphate and sulphate of ammonia.

Under these circumstances, the mixture absorbs one equivalent of carbonic acid for every four equivalents of ammonia; therefore, if the superphosphate process be substituted for the ordinary washers and scrubbers, a large proportion of the carbonic acid and also the whole of the sulphureted hydrogen is left in the gas, and must be dealt with in other ways.

This superphosphate process has been at work at the South Metropolitan Gas Works, Old Kent Road, for nearly two years. In practice it is usual to water the superphosphate before use with ammoniacal liquor, and it is used in dry purifiers, in layers about eight inches thick.

This process has been thoroughly investigated at the Munich Gas Works, by Drs. Bunte and Schilling, and the report made by these gentlemen proves its practical efficiency, and therefore the question of its advantage, as compared with washing and scrubbing, is based chiefly upon



SUGGESTIONS IN ARCHITECTURE.—DESIGN FOR A VILLA.

financial considerations. It is evident that in foreign parts, or in any place where there is a difficulty in disposing of the ammonia, the obtaining of the same in a dry form offers several advantages as compared with having it as a weak solution.

RECONVERSION OF NITRO-GLYCERIN INTO GLYCERIN.

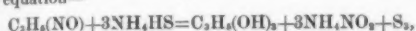
By C. L. BLOXAM.

THE following experiments on this subject appear to possess some interest at the present moment:

1. Nitro-glycerin was shaken with methylated alcohol, which dissolves it readily, and the solution was mixed with an alcoholic solution of KHS (prepared by dissolving KHO in methylated spirit, and saturating with H_2S gas). Considerable rise of temperature took place, the liquid became red, a large quantity of sulphur separated, and the nitro-glycerin was entirely decomposed.

2. Nitro-glycerin was shaken with a strong aqueous solution of commercial K_2S . The same changes were observed as in 1, but the rise of temperature was not so great, and the liquid became opaque very suddenly when the decomposition of the nitro-glycerin was completed.

3. The ordinary yellow solution of ammonium sulphide used in the laboratory had the same effect as the K_2S . In this case the mixture was evaporated to dryness on the steam bath, when bubbles of gas were evolved, due to the decomposition of the ammonium nitrite. The pasty mass of sulphur was treated with alcohol, which extracted the glycerin, subsequently recovered by evaporation. Another portion of the mixture of nitro-glycerin with ammonium sulphide was treated with excess of $PbCO_3$, and a little lead acetate, filtered, and the ammonium nitrite detected in the solution. These qualitative results would be expressed by the equation—



which is similar to that for the action of potassium hydrosulphide upon gun-cotton.

4. Flowers of sulphur and slaked lime were boiled with water, till a bright orange solution was obtained. This was filtered, and some nitro-glycerin poured into it. The reduction took place much more slowly than in the other cases, and more agitation was required, because the nitro-glycerin became coated with sulphur. In a few minutes, the reduction appearing to be complete, the separated sulphur was filtered off. The filtrate was clear, and the sulphur bore hammering without the slightest indication of nitro-glycerin.

This would be the cheapest method of decomposing nitro-glycerin. Perhaps the calcium sulphide of tank-waste, obtainable from the alkali works, might answer the purpose.—*Chemical News.*

CARBONIC ACID AND BISULPHIDE OF CARBON.*

By JOHN TYNDALL, F.R.S.

CHEMISTS are ever on the alert to notice analogies and resemblances in the atomic structure of different bodies. They long ago indicated points of resemblance between bisulphide of carbon and carbonic acid. In the case of the latter we have one atom of carbon united to two of oxygen, and in the case of the former one atom of carbon united to two of sulphur. Attempts have been made to push the analogy still further by the discovery of a compound of carbon and sulphur analogous to carbonic oxide, but hitherto, I believe, without success. I have now to note a resemblance of some interest to the physicist, and of a more settled character than any hitherto observed.

When, by means of an electric current, a metal is volatilized and subjected to spectrum analysis, the "reversal" of the bright band of the incandescent vapor is commonly observed. This is known to be due to the absorption of the rays emitted by the vapor by the partially cooled envelope of its own substance which surrounds it. The effect is the same in kind as the absorption by cold carbonic acid of the heat emitted by a carbonic oxide flame. For most sources of radiation carbonic acid is one of the most transparent of gases; for the radiation from the hot carbonic acid produced in the carbonic oxide flame it is the most opaque of all.

Again, for all ordinary sources of radiant heat, bisulphide of carbon, both in the liquid and vapor form, is one of the most diathermanous bodies ever known. I thought it worth while to try whether a body reputed to be analogous to carbonic acid, and so pervious to most kinds of heat, would show any change of deportment when presented to the radiation from hot carbonic acid. Does the analogy between the two substances extend to the vibrating periods of their atoms? If it does, then the bisulphide, like the carbonic acid, will abandon its usually transparent character, and play the part of an opaque body when presented to the radiation from the carbonic oxide flame. This proved to be the case. Of the radiation from hydrogen, a thin layer of bisulphide transmits 90 per cent., absorbing only 10. For the radiation from carbonic acid, the same layer of bisulphide transmits only 25 per cent., 75 per cent. being absorbed. For this source of rays, indeed, the bisulphide transcends, as an absorbent, many substances which, for all other sources, far transcend it.

THE HAIR, ITS USE AND ITS CARE†

By JOHN V. SHOEMAKER, A.M., M.D., Physician to the Philadelphia Hospital for Skin Diseases.

THE object of this paper is to briefly describe the hair and its important functions, and to suggest the proper manner of preserving it in a healthy state.

I know full well that much has been written upon this useful part of the human economy, but the constant increase of bald heads and beardless faces, notwithstanding all our modern advancement in the application of remedies to the cure of disease, prompts me to point out to you the many ways of retaining, without medication, the hair, which is a defense, ornamentation, and adornment to the human body.

[Dr. Shoemaker here gave an interesting history of the growth and development of the hair and its uses, which we are compelled to omit. Then, proceeding, he said:] Now, the hair, which fulfills such an important function in the adornment and health of the body, requires both constitutional and local care to keep it in its normal, healthy state. When I say constitutional care, I mean that the various organs of the body that assist in nourishing and sustaining the hair-forming apparatus should, by judicious diet, exer-

else, and attention to the nervous system, be kept healthy and sound, in order that they in turn may assist in preserving the hairs in a vigorous condition.

In the first place, that essential material, food, which is necessary to supply the waste and repair of all animal life, should be selected, given, or used according to good judgment and experience.

Thus, mothers should feed their infants at regular intervals according to their age, and not permit them to constantly pull at the breast or the bottle until the little stomach becomes gorged with food, and some alimentary disorder supervenes, often setting up a rash and interfering with the growth and development of the hair. It is likewise important, in case the baby must be artificially fed, to select good nutritious food as near as possible like the mother's—cow's milk, properly prepared, being the only recognized substitute. Care and discretion should likewise be taken by parents and nurses, after the infant has developed into childhood, to give simple, substantial, and varied food at regular periods of the day, and not in such quantities as to overload the stomach. Children need active nutrition to develop them into robust and healthy men and women; and it is from neglect of these important laws of health, and in allowing improper food, that very often bring their results in scald head, ring-worm, and scrofula, that leave their stamp in the poor development of the hair. With the advent of youth and the advance of years, food should be selected and partaken of according to the judgment and experience of its acceptable and wholesome action on the consumer.

The meals should also be taken at regular intervals. At least four hours should be left between them for the act of digestion and the proper rest of the stomach.

It is, on the contrary, when the voice of nature has been stifled, when judgment and experience have been set aside, that mischief follows; when the stomach is teased and fretted with overloading, and the food gulped down without being masticated, gastric and intestinal derangement supervenes, which is one of the most prolific sources of the early decay and fall of the hair.

The nervous system, which is one of the most important portions of the human structure, and which controls circulation, secretion, and nutrition, often being impaired, plays a prominent part in the production of baldness. Thus, it has been demonstrated by modern investigation that the nerves of nutrition, by their defective action, are often the cause of thinning and loss of hair. The nutritive action of a part is known to suddenly fail, the hair-forming apparatus ceases to act, the skin changes from a peculiar healthy hue to a white and shining appearance, and often loses at the same time its sensibility; the hairs drop out until very few remain, or the part becomes entirely bald. It is the overtaxing of the physical powers, excessive brain work, the exacting demands made by parents and teachers upon children's mental faculties, the loss of sleep, incessant cares, anxiety, grief, excitement, the sudden depression and exaltation of spirits, irregular and hastily bolted meals, the lack of rest and recreation, the abuse of tobacco, spirits, tea, coffee, and drugs of all forms, that are fruitful sources of this defective action of the nerves of nutrition, and consequent general thinning and loss of hair.

The hair, particularly of the head, should also receive marked local attention. In reference to the use of coverings for it, I know of no better rules than those which I laid down in my chapter on clothing in "Household Practice of Medicine" (vol. i., p. 218, William Wood & Co., New York), in which I state that the head is the only part of the body so protected by nature as to need no artificial covering.

The stiff hats so extensively worn by men produce more or less injury. Premature baldness most frequently first attacks that part of the head where pressure is made by the hat. It is, indeed, a pity that custom has so rigidly decreed that men and women must not appear out of doors with heads uncovered. It would be far better for the hair if to be bare-headed were the rule, and to wear a hat the exception.

Since we cannot change our social regulations in this respect, we should endeavor to render them as harmless as possible.

The forms of hats that are least injurious are: for Winter, soft hats of light weight, having an open structure, or pierced with numerous holes; for Summer, light straws, also of open structure.

As regards the head-covering of women, the fashions have been for several years favorable to proper form. The bonnet and hat have become quite small, and cover but little of the head. This beneficial condition, however, is in part counterbalanced by the weight of false curls, switches, puffs, etc., by the aid of which women dress the head. These, by interfering with evaporation of the secretions, prevent proper regulations of the temperature of the scalp, and likewise lead to the retention of a certain amount of excrementitious matter, both of which are prolific sources of rapid thinning and loss of hair in women.

False hair has likewise sometimes been the means of introducing parasites, which give rise to obstinate affections of the scalp.

Cleanliness of the entire surface of the skin should next demand attention, and that should be done by using water as the medium of ablution. It is a well-known physiological law that it is necessary, in order to enable the skin to carry on its healthful action, to have washed off with water the constant coat of scales which become mingled with the unctuous and saline products, together with particles of dirt which coat over the pores, and thus interfere with the development of the hairs. Water for ablution can be of any temperature that may be acceptable and agreeable, according to the custom and condition of the bather's health. Many chemical substances can be combined with water to cleanse these effete productions from the skin. Soap is the most efficacious of all for cleanliness, health, and the avoidance of disease. Soap combines better with water to render these unctuous products miscible, and readily removes them thoroughly from the skin. The best variety of soap to use is the pure white soap, which cannot be so easily adulterated by coloring material, or disguised by some perfume or medicinal substance. Ablution with soap and water should be performed once or twice a week at least, particularly to the head and beard, in order to keep open the hair tubes so that they may take in oxygen, give out carbon, carry on their nutrition, and maintain the hairs in a fine, polished, and healthy condition. In using water to the scalp and beard, care should be taken not to use soap-water too frequently, as it often causes irritation of the glands, and leads to the formation of scurf. It is equally important to avoid using on the head the daily shower-bath, which, by its sudden, rapid, and heavy fall, excites local irritation, and, as a result, loss of hair quickly follows. In case the health demands the shower-bath, the hair should

be protected by a bathing cap. The most acceptable time to wash the hair, to those not accustomed to doing it with their morning bath, is just before retiring, in order to avoid going into the open air or getting into a draught and taking cold. After washing, the hair should be briskly rubbed with rough towels, the Turkish towel heated being particularly serviceable. Those who are delicate or sick, and fear taking cold or being chilled from the wet or damp hairs, should rub into the scalp a little bay rum, alcohol, or oil, a short time after the parts have been well chafed with towels. The oil is particularly serviceable at this period, as it is better absorbed, and at the same time overcomes any dryness of the skin which often follows washing.

It might be well to add in this connection that I have frequently been consulted, by those taking salt-water baths, as to the care of the hair during and after the bath. If the bather is in good health, and the hair is normal, the bather can go into the surf and remain at least fifteen minutes, and on coming out should rub the hair thoroughly dry with towels.

Ladies should permit it remain loose while doing so, after which it can be advantageously dressed.

It is, however, often injurious to both men and women having some wasting of the hair to go into the surf without properly protecting the head; the sea water has not, as is often thought, a tonic action on the scalp; on the contrary, it often excites irritation and general thinning. Again, it is most decidedly injurious to the hair for persons to remain in the surf one or two hours, the hair wet, and the head unprotected from the rays of the sun. This latter class of bathers, and those who hurriedly dress the hair wet, which soon becomes mouldy and emits a disagreeable odor, are frequent sufferers from general loss and thinning of the hair.

An agreeable and efficient adjunct after ablution, which I have already referred to, is oil. Oil has not only a cleansing action upon the scalp, but it also overcomes any rough or uneven state of the hair, and gives it a soft and glossy appearance.

The oil of ergot is particularly serviceable in fulfilling these indications, and, at the same time, by its soothing and slight astringent action upon the glands, will arrest the formation of scurf. In using oil, the animal and vegetable oils should always be preferred, as mineral oils, especially the petroleum products, have a very poor affinity for animal tissues.

Ponatum is largely used by many in place of oil, as it remains on the surface and gives a full appearance to the hairs, thus hiding, sometimes, the thinness of the hair.

It will do no harm or no special good if it contains pure grease, wax, harmless perfume, and coloring matter, but it is often highly adulterated, or, the fat in it decomposing, sets up irritation on the part to which it is applied. I therefore always advise against its use.

The comb and brush are also agents of the toilet by which the hair is kept clean, vigorous, and healthy. The comb should be of flexible gum, with large, broad, blunt, round, and coarse teeth, having plenty of elasticity. It should be used to remove from the hairs any scurf or dirt that may have become entangled in them, to separate the hairs and prevent them from becoming matted and twisted together.

The fine-tooth comb, made with the teeth much closer together, can be used in place of the regular toilet comb just named when the hair is filled with very fine particles of scurf, dirt, or when parasites and their eggs infest the hairs. It should, however, always be borne in mind that combs are only for the hair, and not for the scalp or the skin, which is too often torn and dug up by careless and roughly pulling these valuable and important articles of toilet through the skin as well as the hair.

The brush with moderately stiff whalebone bristles may be passed gently over the hair several times during the day, to brush out the dust and the dandruff, and to keep the hair smooth, soft, and clean; rough and hard brushing the hair with brushes having very stiff bristles in them, especially the metal or wire bristles, is of no service, but often irritates the parts and causes the hair to fall out. [Dr. Shoemaker then denounced the use of the so-called electric brush, saying its use was injurious, as also was the effort to remove dandruff by the aid of the comb and brush. Continuing, he remarked:] And now the question arises, Should the hair be periodically cut? It may be that cutting and shaving may for the time increase the action of the growth, but it has no permanent effect either upon the hair-bulb or the hair sac, and will not in any way add to the life of the hair.

On the contrary, cutting and shaving will cause the hair to grow longer for the time being, but in the end will inevitably shorten its term of life by exhausting the nutritive action of the hair-forming apparatus. When the hairs are frequently cut, they will usually become coarser, often losing the beautiful gloss of the fine and delicate hairs. The pigment will likewise change—brown, for instance, becoming chestnut, and black changing to a dark brown. In addition, the ends of very many will be split and ragged, presenting a brush-like appearance. If the hairs appear stunted in their growth upon portions of the scalp or beard, or gray hairs crop up here and there, the method of clipping off the ends of the short hairs, of plucking out the ragged, withered, and gray hairs, will allow them to grow stronger, longer, and thicker.

Mothers, in rearing their children, should not cut their hair at certain periods of the year (during the superstitious time of full moon), in order to increase its length and luxuriance as they bloom into womanhood and manhood. This habit of cutting the hair of children brings evil in place of good, and is also condemned by the distinguished worker in this department, Professor Kaposi, of Vienna, who states that it is well known that the hair of women who possess luxuriant locks from the time of girlhood never again attains its original length after having once been cut.

Pincus has made the same observation by frequent experiment, and he adds that there is a general opinion that frequent cutting of the hair increases its length; but the effect is different from that generally supposed. Thus, upon one occasion he states that he cut off circles of hair an inch in diameter on the heads of healthy men, and from week to week compared the intensity of growth of the shorn place with the rest of the hair. The result was surprising to this close and careful observer, as he found in some cases the numbers were equal, but generally the growth became slower after cutting, and he has never observed an increase in rapidity.

I might also add that I believe many beardless faces and bald heads in middle and advancing age are often due to constant cutting and shaving in early life. The young girls and boys seen daily upon our streets with their closely cropped heads, and the young men with their clean-shaven

* A paper read before the Royal Society, April 5, 1883.

† Abstract of a paper read before the Pennsylvania State Medical Society, at Norristown, May 10, 1883.—*N. Y. Med. Jour.*

faces, are, year by year, by this fashion, having their hair-forming apparatus overstrained.

I also must condemn the modern practice of curling and crimping, the use of hand-line, powders, and all varieties of gum solutions, sharp hair-pins, long-pointed metal ornaments and hair combs, the wearing of chignons, false plaits, curls, and frizzes, as the latter are liable to cause headaches and tend to congestion. Likewise I protest against the use of castor-oil and the various mixtures extolled as the best hair-tonics, restoratives, vegetable hair-dyes, or depilatories, as they are highly injurious instead of beneficial, the majority of hair-dyes being largely composed of lead salts. But, should your patients wish to hide their gray hairs, probably the best hair-dye that can be used safely is pyrogallol acid or walnut juice, the hairs being first washed with an alkaline solution to get rid of the grease. Nitrate of silver is also a good and safe hair-dye, but its application should be done by one experienced in its use. The judicious use of these hair-dyes will give the hair above the surface of the skin a brownish-black appearance, the intensity of the color of which depends upon the strength of the solution. But hair-dyeing for premature grayness should be avoided, as the diseased condition may be averted by the proper remedies. Never permit the hair to be bleached for the purpose of obtaining the fashionable golden hue, as the arsenical solution generally used is highly dangerous; but, if your patients must have their hair of a golden color, insist upon their hair-dresser using the peroxide of hydrogen, which is less dangerous than the preparation first mentioned.

Perhaps one of the most pernicious compounds used for the hair at the present day is that which is sold in the shops as a depilatory. It is usually a mixture of quicklime and arsenic, and is wrongly used and recommended at this time by many physicians to remove hairy moles and an excessive growth of hair upon ladies' faces. Its application excites inflammation of the skin; and, while it removes the hair from the surface for a time, it often leaves a scar, or makes the part rough, congested, and deformed.

In the meantime, the hair will grow after a short period stronger, coarser, and changed in color, which will even more disfigure the person's countenance. With the present scientific knowledge of the application of electrolysis, hairs can be removed from the face of ladies or children, or in any improper situation, in the most harmless manner without using such obnoxious and injurious compounds as depilatories.

In conclusion, let me add that, if the hair becomes altered in texture, or falls out gradually or suddenly, or changes in color, a disease of the hair, either locally or generally, has set in, and the hair, and perhaps the constitution, now needs, as in any other disease, the constant care of the physician.

A general remedy for this or that hair disease that may develop will not answer, as hair diseases, like other affections, have no one remedy which will overcome wasting, thinning, or loss of color. Patients reasoning upon this belief, frequently apply to me for a remedy to restore their hair to its full vigor or give them back its color. I always reply that I have no such remedy.

The general health, as well as the scalp and hairs, must be examined carefully, particularly the latter, with the lens and microscope. All changes must be watched, and the treatment varied from time to time according to the indications.

No one remedy can, therefore, under any circumstances, suit, as the remedy used to-day may be changed at the next or succeeding visit. No remedy for the hair will be necessary if the foregoing advice be followed which I have just narrated, and which is the result of some seven years of labor and experience.

The proper consideration and putting into practice of these suggestions will most certainly secure to the rising generation fewer bald heads and more luxuriant hair than is possessed at the present day.

[Concluded from SUPPLEMENT No. 387, page 6179.]

THE INFLUENCE OF EFFECTIVE BREATHING IN DELAYING THE PHYSICAL CHANGES INCIDENT TO THE DECLINE OF LIFE, AND IN THE PREVENTION OF PNEUMONIA, CONSUMPTION, AND DISEASES OF WOMEN.

By DAVID WARR, M.D., 9 East 12th Street, New York.

PNEUMONIA.

DURING the past winter inflammation of the lungs has destroyed the lives of many persons who, although they were in most cases past the meridian of life, yet still apparently enjoyed vigorous health, and, I have little doubt, would still have been alive and well had the preventive means here laid down against the occurrence of the disease from which they perished been effectively practiced at the proper time.

The most important anatomical change occurring during the progress of pneumonia is the solidification of a larger or smaller part of one or both lungs by the deposit in the terminal bronchial tubes and in the air cells of a substance by which the spongy lungs are rendered as solid and heavy as a piece of liver. The access of the respired air to the solidified part being totally prevented, life is inevitably destroyed if a sufficiently large portion of the lungs be invaded.

This deposit succeeds the first or congestive stage, and it occurs with great rapidity; an entire lobe of the lung may be rendered perfectly solid by the exudation from the blood of fully two pounds of solid matter in the short space of twelve hours or even less. The rapidity with which the lungs become solidified amply accounts for the promptly fatal results that often attend attacks of acute pneumonia. If recovery takes place, the foreign matter by which the lung tissue has been solidified is perfectly absorbed and the diseased portion is found to be quite uninjured. The only natural method by which the blood can be freed from the presence of foreign matter is by the oxidation—the burning—of such impure matters; the results being carbonic acid gas that escapes by the lungs and certain materials that are eliminated chiefly by the kidneys. But when these blood impurities exist in the vital fluid in unusually large quantities, or if the respiratory capacity be inadequate, the natural internal crematory operations are a partial failure. But nature will not tolerate the presence of such impurities in the vital fluid; if they cannot be eliminated by natural means they must by unnatural means; therefore such material is very frequently deposited in various parts of the body, the point of deposit being often determined by some local disturbance or irritation.

For instance, if a person whose blood is in fairly good condition takes a cold that settles on his lungs, he either recovers of it spontaneously or is readily cured by means of

some cough mixture; but if his blood be loaded with tubercular matter, the latter is extremely liable to be deposited in his lungs; the cough that was excited in the first place by a simple cold becomes worse and persistent, in a few months his lungs show signs of disorganization, and he has consumption of the acute or chronic type, as the case may be.

On the other hand, if the impure matter by which the blood is loaded be of the kind that causes the pulmonary solidifications of pneumonia, the latter disease is very likely to be developed if a cold on the lungs be caught.

The liability of any individual to attacks of acute pneumonia is therefore determined very largely by the presence or absence in his blood of the matter already alluded to. If his blood be free from it, no cold, however severe, is competent to originate the disease.

There can be no question but that good living and sedentary habits have a strong tendency to befoul the blood; the former renders effective respiration all the more necessary for the removal from the blood of whatever nutritive matter has been taken beyond the needs of the system, and the latter inevitably diminishes the respiratory motions to the lowest point consistent with physical comfort. From these conditions originates the active predisposing cause of pneumonia, to which we have already alluded.

The disease is more fatal in the very young and in the aged; the mortality seems to bear a direct ratio to the respiratory capacity; in young subjects the breathing powers have not been fully developed like the other physical capacities, while in the old the respiratory volume has been diminished by the stiffening of the chest walls and of the lungs by the senile changes already detailed.

There can be no question but that protection from cold and judicious attention to the health generally, by suitable exercise and diet, has a powerful tendency to prevent that overloaded condition of the blood to which I believe acute pneumonia to be chiefly due; still I have no doubt but that the most active preventive measure that can be adopted is keeping up the respiratory capacity to the full requirements of the system, a precaution which is specially necessary to ease-loving and high-living gentlemen who are past the prime of life. I am of the opinion that if such persons would cultivate their breathing powers by the simple means here recommended, their liability to pneumonia would be notably reduced.

THE TRUE FIRST STAGE OF CONSUMPTION.

The progress of tubercular consumption has been divided by pathologists into three stages. The first stage being that in which a deposit of tubercular matter occurs in the lung tissue, the second is entered on when the tubercles soften, and the third when they have melted down, been expectorated, and cavities have formed. But the real beginning of this most insidious and justly dreaded disease not unfrequently antedates for a long time, often for several years, the deposit of any tubercular matter. During all this time an expert examiner can detect the slight but very significant changes already taking place in the pulmonary organs. Physicians determine the condition of the lungs chiefly through the sounds elicited by percussion of the chest walls by the end of the middle finger, or a small rubber hammer adapted to the purpose, and by those produced by the respired air rushing into and out of the bronchial tubes and air vesicles. The percussion sounds yielded by the chest during what has been aptly called the pre-tubercular stage do not differ from those elicited in health, because it is only when some morbid matter exists in the lungs that the percussion note is altered, therefore negative results only are obtained in the real first stage by this mode of examination. But important information can be obtained by interrogating the sounds due to the inspired air rushing into and distending the air vesicles. When the lungs are perfectly healthy, these are breezy and almost musical. During the pre-tubercular stage they become drier and harsher; qualities of evil omen that continue to increase as time passes, if properly directed means be not adopted to correct the evil; but so far none of the symptoms that indicate the slightest deposit of tubercle can be detected, but the breathing capacity of such persons is never up to the full requirements of the system. The reader is referred to the table already given, which exhibits the decline of the breathing capacity of persons suffering from consumption in its several stages. When the disease has made such decided progress that tubercles are already deposited in the lungs in sufficient quantity to give rise to the physical signs by which their presence is proved, this carefully compiled table shows that the diminution of the vital capacity already amounts to one-third of that considered by Dr. Hutchinson to be necessary to the maintenance of health.

During the pre-tubercular stage the breathing capacity rarely falls so much as 33 per cent. below the healthy standard, but it is never up to the normal vital volume. This fact is most significant, especially when it occurs in an individual whose relatives have succumbed to this disease; but it rarely attracts sufficient attention from such persons as to induce them to have their breathing capacity measured, much less to take effective measures to bring and keep it up to the healthy standard. So long as there are, to them, no tangible symptoms of approaching mischief, and they feel fairly well, they act as if they thought "that all men were mortal but themselves." Yet it is from among persons who have an inherited but latent tendency to tubercular disease, and whose lung power is below par, that the great army of consumptives who die every year is recruited. It is very difficult to induce persons who ought to be interested in this matter to take effective measures for their future safety when the terrible symptoms accompanying the last stages of the disease often fail to shake the sufferer's confident expectation of recovery; and we sometimes see them engaged in laying plans for the future when death is imminent. I regret deeply to be obliged to make these statements, because I am convinced that if the suggestions laid down in this work were generally reduced to practice by those who have reason to dread the development of tubercular disease, many valuable lives would be saved.

THE DEVELOPMENT OF TUBERCULAR MATTER IN THE BLOOD.

During the digestive processes the starchy, saccharine, and albuminoid elements of food are dissolved, and the fatty matters are emulsified. A uniform milky solution is thus formed, which is rapidly absorbed into the general circulation; some of it passes directly through the walls of the vessels into the blood, and some is taken up by the lacteals and reaches the vital fluid by traversing the complicated series of tubes known as the absorbent system, and the numerous glands connected with it. The chief function of the starchy and fatty food elements is to keep up the physical temperature, by being submitted to oxidation in the organism; therefore it is not necessary that they should experience any vitalizing change, but are fitted to discharge their duties in

the vital domain by simply undergoing the solution that fits them for absorption. But the materials intended to enter into the composition of the body must be developed into living blood, in order to be fitted to become part and parcel of the organs by which power is evolved, and through the use of which we see, hear, feel, think, and move. This wonderful process begins and is carried forward in the absorbent system, which has been described by Dr. Carpenter as a great blood-making gland. But the vital transformation is not completed until the nutritive materials have been submitted to the action of the liver, and afterward to the influence of oxygen in the capillaries of the lungs. The food that was eaten a few hours before is thus converted into rich, scarlet arterial blood, if every part of the complex vitalizing processes has been properly conducted. But the influence of oxygen is requisite, not only to complete the vitalization of the embryo blood in the lungs, it is an absolutely essential element in every step of the vitalizing process in the absorbents.

The average quantity of food required to sustain an ordinary man in health and strength, I have previously stated, is about two pounds avoirdupois daily, and an equal weight of oxygen is necessary to the integrity of the vitalizing processes undergone by the food, and to maintain the physical temperature. When the requisite supply of oxygen is reduced, the extrication of heat within the system is promptly diminished, but the vitalization of digested food is unfavorably affected much more slowly, but with equal certainty. If the quota of oxygen existing in the arterial blood of the vessels whose duty it is to supply the vital fluid to the absorbent system, be inadequate to enable these operations to go on properly, the life-giving processes must necessarily be imperfectly accomplished. Under these circumstances the digested material is imperfectly vitalized, and is therefore inadequately fitted to be used in building up and repairing the living body. But its course in the system cannot be delayed, much less stopped.

The blood possesses a definite constitution, which cannot be materially altered without the rapid development of grave, perhaps fatal consequences. The nutritive matters received into the blood must be given up by it to the tissues for their repair, whether such materials are well or ill fitted for the vital purposes. Dr. B. W. Carpenter, of London, the celebrated physiologist, makes the following pertinent statements on this subject, which I condense from his great work on physiology: "We frequently find an imperfectly organizable product, known by the designation of tubercular matter, taking the place of the normal elements of tissue, both in the ordinary process of nutrition, and still more when inflammation is set up.

From the examination of the blood of tuberculous subjects it appears that, although the bulk of the coagulum obtained by stirring or beating is usually greater than that of healthy blood, yet this coagulum is not composed of well elaborated fibrine, for it is soft and loose, and contains an unusually large number of colorless blood corpuscles, while the red corpuscles form an abnormally small proportion of it. We can understand, therefore, that such a constant deficiency in capacity for organization must unfavorably affect the ordinary nutritive processes; and that there will be a liability to the deposit of imperfectly vitalized matter, instead of the normal elements of tissue, even without any inflammation. Such appears to be the history of the formation of tubercles in the lungs and other organs.

When it occurs as a kind of metamorphosis of the ordinary nutritive processes and in this manner, it may proceed insidiously for a long period, so that a large part of the tissue of the lungs shall be replaced by tubercular deposit without any other sign than an increasing difficulty of respiration." These views are strongly corroborated by the following facts:

In making post mortem examinations of persons who have died of consumption, tubercles of different kinds are found in the same subject; some of these, having been deposited during what is called the first stage of the disease, before the breathing powers were much impaired, bear evident traces of organization in the form of cells and fibers more or less obvious, these being sometimes almost as perfectly formed as living matter, at least on the superficial part of the deposit, which is in immediate contact with the living structures around.

This variety of tubercle has a tendency to contract and remain in the lungs without doing much injury. But as the disease progressed, and the breathing capacity progressively diminished, tubercular matter occurs, evincing less and less organization, showing a tendency to break down and cause inflammation in the surrounding lung tissue, until at last we find crude yellow tubercles that have become softened, and formed cavities almost as soon as they were deposited.

Some cases of chronic consumption pass in a few months through the various stages from the deposit of the first tubercle to a fatal termination.

The progress of the disease is determined largely by the nature of the tubercular matter at the time it is deposited.

The variety of matter which has been partially vitalized commonly exists in small quantity, has a strong tendency to maintain its semi-organized condition unchanged by time, and rarely causes inflammation.

A small or moderate quantity of this sort of tubercle exists in the lungs of many persons, in whom it produces no tangible symptoms, and who are therefore quite unconscious of its presence; and even when it does exist in sufficient quantity to develop the symptoms of lung disorder, the progress of the disease is slow, often continuing for many years. It constitutes a variety of consumption which is specially amenable to proper treatment. On the other hand, the soft, yellow, cheesy, tubercular matter, which is totally destitute of any vitality, is too often deposited in large quantities, acts on the adjacent lung tissue as an active irritant, causes inflammation, undergoes softening, forms cavities, defies treatment, and rapidly hurries the sufferers to a premature grave. These facts, taken in connection with the immunity from lung diseases enjoyed by those whose respiratory capacity is well developed and properly used, as well as the beneficial effects that are promptly secured in the favorable varieties of consumption by any important increase in the vital volume, I believe fully justify the statement that tubercles are the results of defective nutrition directly traceable to inadequate respiratory capacity, either congenital or acquired—in other words, tubercles are composed of particles of food which have failed to acquire sufficient life while undergoing the vital processes, because the person in whom they occur habitually breathed too little fresh air.

Persons who possess what is called the scrofulous constitution are specially liable to the occurrence of tubercular matter when their respiration is defective, or they are exposed to any other influences that favor its development in

the organism. But habitually defective respiration, or the breathing of an atmosphere containing too little oxygen, which practically amounts to the same thing, has a very powerful tendency in the same direction, in persons who are apparently as free from scrofulous taint as any human being can be.

THE VALUE OF COD-LIVER OIL IN THE PREVENTION OF CONSUMPTION.

There is a broad but not commonly recognized distinction between what constitutes a medicine and a food. All the materials that normally enter into the composition of the living body, and are necessary to the maintenance of health and strength, may be properly classed as foods, whether they be obtained from the animal, vegetable, or mineral kingdoms; thus the iron, sulphur, phosphorus, lime, potash, etc., required by the system usually exist in and are organically combined with the various foods in common use, and they are perhaps quite as essential to the physical well-being as albuminoid, fatty, and saccharine matters. When the system is suffering from lack of any of the above mentioned chemicals, their administration is to be regarded as the giving of nutritive substances, although they be prescribed by a physician in divided doses and procured from a pharmacist.

On the other hand, a medicine is any substance that does not naturally enter into the composition of the body, but which has the power, when skillfully used, to modify the physical processes so that physiological disorder—disease, shall be replaced by physiological harmony—health. Belladonna, hyoscyamus, opium, etc., are familiar examples of medicaments. Therefore a food is any substance that is capable of directly contributing to the nutrition of the body, and medicine is a substance competent, under proper conditions, to secure the same results indirectly. Viewed in the light of the above definition, cod-liver oil is to be regarded as a very valuable food, as well as a most effective remedy both for the prevention and cure of consumption.

I have previously stated that food is divided by physiologists into three great classes. The albuminoids are used to build up the organism, while the fatty and saccharine are burned in the body to keep it warm. Although these are the chief functions devolving on the above mentioned food elements, yet they are mutually interdependent on each other for the proper performance of their several offices. Thus the albuminoids cannot undergo the wonderful vitalizing process necessary to fit them to enter into and form part of the living body, except an adequate quantity of fatty matter be present to assist in the vital transformation. On the other hand, the assistance of the albuminoids is equally necessary to enable the fatty and saccharine foods to maintain the internal heat of the body. Of all fatty matters, whether derived from the animal or vegetable kingdom, none possesses the property of stimulating and perfecting the nutritive processes in so high a degree as cod-liver oil; it is more readily emulsified and fitted for absorption by the pancreatic secretion during intestinal digestion than any other fatty matter of which we have any knowledge. The beneficial effects of its use have been proved in myriads of cases of confirmed consumption, and if it were used for prolonged periods by persons who are losing weight, and whose breathing capacity is too little, along with effective cultivation of the latter function, many persons would escape this disease who now succumb to it.

THE INFLUENCE OF NORMAL BREATHING ON THE FEMALE GENERATIVE ORGANS.

The body is divided into three separate stories by two partitions. The diaphragm, A, separates the cavity of the chest from that of the abdomen. The partition, D, forms a

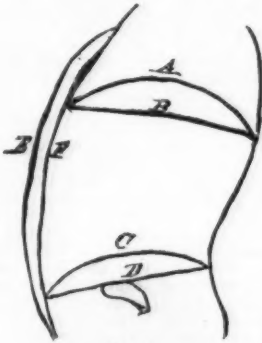


FIG. 1.

floor for the digestive cavity, F, and a roof for the pelvis; the pelvic cavity is occupied mainly by the generative organs. The upper part of the uterus is firmly fixed to the partition, D, by which the pelvis is covered. Now, the diaphragm, A, and the external respiratory muscles are in ceaseless motion performing the act of breathing. The diaphragm acts like the piston of a pump, both on the lungs above, and on the contents of the abdominal and pelvic cavities below. When it rises from B to A, it diminishes the size of the thoracic cavity, compresses the lungs, and assists in the expiratory part of breathing; at the same time it acts through the contents of the abdominal cavity on the pelvic roof, D, to which the uterus is attached, and raises it from D to C. When the diaphragm contracts, it descends from A to B, increases the size of the thoracic cavity, inflates the lungs, promotes the inspiratory part of breathing, pushes the walls of the chest and abdomen outward from F to E, and lowers the pelvic roof at the same time the uterus sinks from C to D. When the effect of these respiratory motions is not diminished by muscular debility, rigidity of the thoracic walls, or by unsuitable clothing, they have so direct an effect on the pelvic contents that the uterus and its appendages make two distinct motions every time a woman breathes. When the diaphragm rises and the breath is expelled, the womb is elevated from one inch to one inch and a half, because the roof of the pelvis, to which it is attached, is lifted about this distance, because of gentle suction from above. The uterus and its appendages are thus kept in constant motion, up and down, chiefly by action of the muscles by which breathing is carried on.

Several influences combine to maintain the circulation of the blood. The pumping action of the heart and the affinity of the blood for the walls of the capillary vessels require to be assisted by the motion both of the body as a whole and of its parts in order to keep the circulation flowing

equally through every tissue. Therefore muscular action and the resulting bodily motion play a very important part in maintaining the general and local blood circulation. During the contraction of a muscle, the blood current flowing through it is, for the time being, retarded, but when relaxation occurs the blood flows into its vessels more freely than if no momentary cessation had taken place. When the body or any of its parts is deprived of motion, the blood circulation stagnates, and the nutrition, general or local, as the case may be, promptly becomes impaired. This is especially true of the uterus. Gentle but constant motion is absolutely essential to keep up a healthy uterine blood circulation. Nature has provided for the automatic performance of all the ceaseless internal motions that are necessary to the continuance of life and the preservation of health; thus the heart beats, the respiratory muscles act, the stomach executes a churning motion during gastric digestion, the intestines pass on their contents by worm-like contractions, automatically without our supervision and without causing fatigue, being under the control of the sympathetic system of nerves chiefly. It is equally true, but not so well recognized, that the previously described motions that are committed to the pelvic organs from the respiratory apparatus are absolutely necessary to the continued health of the uterus and its appendages. But the womb is not under the control of the voluntary muscles, therefore it cannot be directly moved by them, nor are its necessary motions influenced by the sympathetic system of nerves as are the heart, stomach, and intestines, etc., but it is fortunately under the indirect but positive control of involuntary muscles that never, as long as breathing continues, cease their work. Nature has thus made ample provision to keep the uterus in automatic motion. As before stated, the natural ceaseless heavings of the lungs, chest, and diaphragm, aided by the muscles inclosing the abdomen, have the duty assigned them of communicating automatic motion to the uterus and the contents of the pelvis. When the diaphragm descends from A to B, and the lungs are filled with air, the uterus sinks in the pelvic cavity in obedience to the downward pressure from above, as before stated; the circulation through the uterus is then for a moment retarded, but the next instant, when the lungs are emptied of air and the diaphragm rises, the blood flows forward more freely than if it had not been momentarily obstructed. Ample provision has thus been made to maintain a healthy circulation through the uterus.

The uterine motions I have described are fully adequate for the purposes indicated. But when the natural stimulus of motion is withheld, the circulation becomes sluggish causing congestion, which may develop into inflammation. Under these conditions the uterus gradually becomes displaced, falling backward, forward or downward as the case may be. The blood vessels by which the uterus is supplied thus have their caliber diminished by bending; the circulation through them is retarded just as the flow of water in a rubber tube is obstructed by a kink. A very good idea of what occurs in the uterus under the conditions just described may be obtained by winding a string around the fingers.

As the coats of the arteries are thick, and the pressure exerted by the ligature has less power to prevent the arterial blood flowing outward past the string to the end of the finger than it has to prevent the return of the venous blood toward the heart, therefore the part beyond the ligature soon becomes congested, the blood stagnating in the capillaries. If the ligature be sufficiently tight and kept on long enough, mortification will take place, but if the circulation be only moderately obstructed, the congestion will continue until ulceration occurs. A similar condition is developed in the uterus when the necessary natural stimulus of motion fails to be communicated to it or when it is so far out of its proper place that the circulation through it is obstructed.

I believe the above described condition to be a most potent but inadequately recognized cause of the various forms of uterine diseases that distress so many women.

SHOWING HOW THE BREATHING POWERS MAY BE DEVELOPED.

When the circumference of the chest bears a due propor-

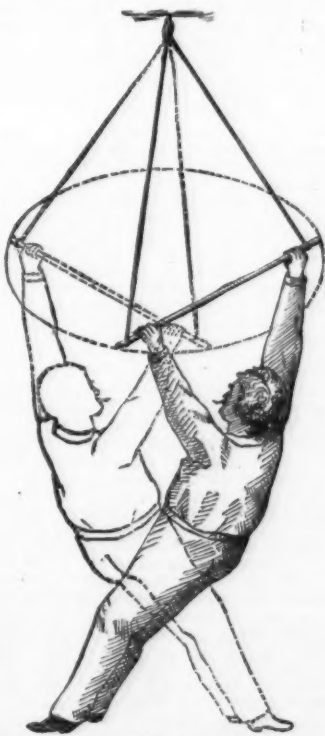


FIG. 2.

tion to the size of the body generally; when its walls and the lungs possess a suitable degree of elasticity; when the strength of the respiratory muscles is adequate to their work, and no undue opposition is offered to the breathing

motions by the clothing—then the vital volume is always up to the full requirements of the system. But when one or all of these are lacking in any important degree, the breathing capacity is proportionately diminished. If the testimony of the spirometer be corroborated by the impaired physical condition of the individual, its correction should be sought in part at least by enlarging the chest, increasing the elasticity of its walls and of the lungs, and by augmenting the

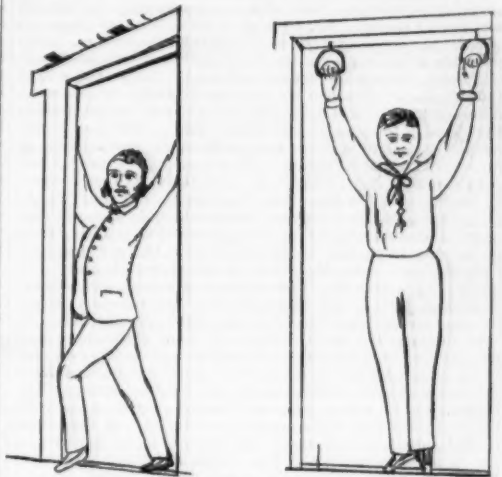


FIG. 3.

strength of the respiratory muscles. These results may commonly be secured by diligent and persevering use of the following exercises:

A trapeze, Fig. 2, should be suspended from the ceiling, so that the bar shall be six inches above the head of the person who is to use it; the toes should be placed under straps nailed to the floor to keep them in position. Then if the bar be grasped and the body thrown forward, the trapeze, the arms, and the body will form the segment of a circle.

The exercise is taken by causing the body to describe a complete circle in the manner indicated in the cut. Little muscular effort is required if the motion be rapid, because the momentum is sufficient to carry the body around; but if the rotation be slow, more exertion is required. This movement is specially adapted to the breathing powers of weak persons, yet the most vigorous can readily get from it all the exercise their chest and lungs require.

By means of these exercises the chest is gently but effectively expanded in every direction and the elasticity of its walls promoted, the air cells are expanded, and the lungs are rendered more permeable to the respired air, and the strength of the respiratory muscles is developed.

Fig. 3 illustrates an exercise for the chest that is taken without any apparatus other than an ordinary doorway. The exerciser should stand in the position indicated in the engraving, and then step forward with each foot alternately as far as possible without stretching the chest too severely. The longer the step the more vigorous the exercise will be.

Fig. 4 shows an exercise taken between two chairs; the



FIG. 4.

position indicated in the cut having been assumed, the chest is then slowly lowered and raised three to six times. This exercise is adapted to strong persons only.

THE EFFECTS OF ADEQUATE RESPIRATION IN SPECIAL CASES.

When the nutrition of the body is promoted by effective respiration, and waste matters are promptly removed, the chances that tubercle will be developed in persons who are predisposed thereto are reduced to a minimum.

Better materials are furnished by the nutritive processes to renew the tissues, so that the occurrence of those degenerations that result in various fatal affections, peculiar to the decline of life, are rendered much less probable or are prevented altogether, and the chances that death shall take place by old age is increased. The system possesses much greater resisting power against the influence of malaria and the poisons that give rise to typhoid fever, scarlatina, diphtheria, measles, etc.

When the motions of a woman's respiratory organs are normal and are properly communicated to the pelvic organs, she enjoys the greatest possible immunity attainable against the development of any diseases peculiar to the sex.

VITAL DISCOVERIES IN OBSTRUCTED AIR AND VENTILATION.*

I SUPPOSE that we all consider ourselves to be sufficiently impressed with the importance of ventilation. If I should stop here to declaim against foul exhalations, or to dwell upon the virtues of fresh air, you might feel inclined to interrupt me by saying, "Oh, we know all about that! If you have anything practical to advance, come to the point." Gentlemen, I beg your pardon, but I must say that the great fact concerning ventilation, as yet, is that its strongest advocates are not conscious of one-half the seriousness of the subject; and the second fact is that the supposed means of ventilation prescribed by science fail to secure it.

This, then, is my point to-night—the supreme necessity, still urgent, and universally urgent, for a reformation of the breath of life. I believe in a promised time when the days of a man's life shall again be as the days of a tree. And next to the abolition of vice and sin, I believe that the very grandest factor of such result must be an entire disuse of

* Read by Wm. C. Conant before the Polytechnic Association of the American Institute, New York, May 30, 1883.

obstructed air for the lungs. I propose to bring forward some evidence of the necessity, and likewise of the possibility, of a reform so radical and sweeping as this. The subject is too wide for the occasion. I shall be able to read only extracts from what I have prepared, in the few minutes that you can give with patience to my unpracticed lecturing.

The best prescription that doctors have to give (when we are not too far gone to take it) is to live out of doors. Why is this? Why is life out of doors proverbially synonymous with robust health? Why is it that a superior vitality, and a singular exemption from disease, notoriously distinguish dwellers in the open air, by land or sea? Without disparaging the virtues of exercise or of bracing temperature, indispensable as these are for the recuperation of enfeebled constitutions, we must admit that among the native and settled inhabitants of the open air high health is the rule in warm climates as well as in cold, and with the very laziest mortals that bask in the sun, or loaf in the woods. The fact is that simple vegetable health seems to be nearly independent of all other external conditions but that of a pure natural diet for the lungs. Man in nature seems to thrive as spontaneously as plants, by the free grace of air, earth, and sun. On the other hand, the very diseases from which houses are supposed to defend us—that most numerous class resulting from colds—are the special scourge of the lives that are most carefully shielded from their commonly supposed cause—exposure to the open air. Those diseases diminish, and entirely disappear, just so far as exposure in the pure and freely moving air becomes complete and habitual. Soldiers, injured to camp life, catch cold if they once sleep in a house; and, generally speaking, the inhabitants of the free air contract colds only by exposure to confined exhalations from their own or other bodies, within the walls of houses. The explanation of this is plain and simple: Carbonic acid detained within four walls accumulates in place of the breath of life—oxygen—and narcotizes the excretory function of the skin. The moment that this great and continual vent of waste and impurity from the system is obstructed, internal derangement ensues in every direction. All hands, so to speak, are strained to extra duty to discharge the noxious accumulation. The lungs labor to discharge the load thrown back upon them, with hastened respiration, increased combustion, and feverish heat. The pores of the mucous membrane in the nose, throat, alimentary canal, or bronchial passages, are forced by an aggravated discharge (or catarrh), and this congestive and inflammatory pressure is a fever also. There is nothing of "cold" about it except as an auxiliary and antecedent, in cases where an external chill has struck upon nerves already half paralyzed by the universal narcotic—carbonic acid—which house dwellers may be said to "smoke" perpetually.

So much for nerve-poison; but blood-poisoning is a still more terrible characteristic of house-protected existence. It is now the almost universal opinion of the medical profession that the whole class of malarial and zymotic diseases that make such frightful progress and havoc in the most civilized communities, are due to living germs with which the exhalations of organic waste and decay are everywhere loaded in inconceivable numbers. They are known to multiply themselves many times over, every two or three hours. They swarm into the blood by millions, through all the absorbents, especially those of the lungs, that drink the atmosphere in which they are suffered to linger and propagate. Mr. Dancer, the eminent microscopist, counted in a sample from such an atmosphere a number of organized germs equivalent to 3,700,000 in the volume of air hourly inhaled by one person. That is over 61,000 germs per minute, and about 2,000 in every breath. In the blood, they still propagate, and feed, and grow, consuming its oxygen, thus defeating its purification, and turning that stream of otherwise healthful and invigorating nutrition into a stream of effete and corrupt matter—a sewer rather than a river of life—or at best an impoverished and impure supply for the support of existence.

The same pestilential but invisible hosts of bacteria, mustered and bred in the close filthiness of Oriental cities, and jungles, swarm out as Asiatic cholera on the wings of the wind, sweeping the wide world with havoc. Settled on the tropical shores of the Eastern Atlantic, they lie in wait for their victims in the sluggish and terrible coast fever. On the western coast of the same ocean, perhaps from some cause connected with oceanic or atmospheric currents, they make devastating irruptions inland, as yellow fever, in every direction where the walls of their inclosure are low enough to be freely passed. These, let us remember, are all essentially the same organic poison that is engendered wherever life and death are plying their perpetual game; and this, like Cleopatra's "worm," will do its kind in the veins of man, wherever obstructions, natural or artificial, temporary or permanent, interfere with its prompt diffusion in the vastness of the general atmosphere. Our "house of life" stands generously open, for every "inmate bad" to come and go through the absorbents, unquestioned, except in the stomach, where the tangible poisons have to go by the act of swallowing and where they are often challenged and ejected. It seems at first thought very strange that we are not so well protected by natural instinct or sensibility from the subtle poisons of the atmosphere as from those that can affect us only by the voluntary act of swallowing. The obvious explanation, however, of this apparent neglect is that Nature protects us in general from gaseous poisons by her own system of ventilation; and if, when we devise houses, necessarily excluding that system, we fail to devise also a sufficient substitute for it, the consequences of such negligence are as fairly due as when we swallow tangible poison.

I have hitherto referred only to the dispersion of poisonous exhalations, as if the best and most necessary thing the atmosphere can do for us were to dilute the dose to a comparatively harmless potency. But this is now known to be not the true remedial process with respect to the zymotic germs. The most wonderful achievement of recent investigation reveals a philosophy of both bane and antidote that astonishes us with its simplicity as much as with its efficiency. At the moment when humanity stands aghast at the announcement that germs are not destroyed by disinfectants, comes the counter discovery that they are rendered harmless by oxygen. It seems that it makes no difference, really, of what sort or from what source are the bacteria that we take into the blood. The only material difference to us depends on the sort of atmosphere in which their hourly generations are bred. For example, the bacteria developed in confined air, from a simple infusion of hay, are found by experiment to be as capable of generating that most terrible of blood poisons, the malignant pustule, as are the bacteria taken from the pustule itself.

On the other hand, the bacteria from the malignant pustule itself, after propagating for a few hours in pure and free air, become a perfectly harmless race, and are actually

injected into the blood with impunity. The explanation of the strange discovery is this—note its extreme simplicity—bacteria bred in copious oxygen perish for want of it as soon as they enter the blood vessels; whereas those inured to an unventilated atmosphere for a few generations, which means only a few hours, are prepared to thrive and propagate infinitely within our veins; and that is the whole mystery of blood poisoning and zymotic diseases. Taken in connection with the narcotic or nerve-poisoning power of carbonic acid (to which all the classes of diseases resulting from colds are due), we have also in this simple but grand discovery the whole mystery of the question with which we set out—why free air is health, and why sickness is a purely domestic product. The restitution of natural health to mankind demands only, but demands absolutely, the constant diffusion in copious and continuous floods of atmospheric oxygen, of the nerve-poisoning carbonic acid of combustion (organic and inorganic), and of the blood-poisoning bacteria of organic decomposition.

We find, then, as a matter both of experience and of philosophy, that life or death, in the main and in the long run, turns on the single pivot of atmospheric movement or obstruction. The resistance of mere rising ground or dense vegetation to a free movement of the air from low-lying levels performs an obstructive office similar to that of the walls and roofs of houses, and with like effect. The inviolable condition of unhealthy seasons and days is a state of rarefaction and stagnation of the atmosphere, when the poison-freighted vapor cannot be lifted and dispersed, and every one complains of the sultry, close, "muggy" (meaning murky) feeling of the air. Few reflect, when fretted by the boisterous winds of March, upon the vital office they perform in dispersing and sanitating the bacteria-laden exhalations let loose by the first warmth from the soaked soil and the macerated deposits of the former year.

The passing air, then, that we breathe so lightly, is on other business, and carries a load we little think of, and that is not to be trifled with. This grand carrier of nature, on business of life or death, must not be detained, must not be hindered! or they who interfere with the business by restraining walls and roofs will take the consequences. It is a good deal like stopping a bullet, except as to consciousness and suddenness of effect.

That men live at all in their obstructed and therefore poison-loaded atmosphere, is a proof of the wonderful efficiency of the protective economy of Nature within us; so wonderful, indeed, that few can believe the fact of living to be consistent with the real existence of such a deadly environment as science pretends to reveal. It is a common impression, therefore, that actual results fail to justify the alarm sounded by sanitarians. Hence the necessity for calling attention at the outset to an ample and manifest equivalent for the deadly dose of confined exhalations taken daily by all civilized men. We perceive that that dose is not lost, like the Humboldt River, in a "sink," but reappears, like the widespread grass, in a perennial and universal crop of diseases, almost numberless and ever increasing in number, peculiar to house-dwellers. The trail of these plagues stops nowhere else; it leads straight to the imprisoned atmosphere in our artificial inclosures, and there it ends. That marvelous protective economy of Nature within us, to which we have referred, is no perpetual guaranty against the consequences of our negligence; it is only a limited reprieve, to afford space for repentance; and unless we hasten to improve the day of grace, the suspended sentence comes down upon us at last with force the more accumulated by delay.

Now, therefore, the grand problem of sanitary science (almost untouched, almost unrecognized) proves to be no other and no less than this:

What can be done to remedy the obstructive nature of an inclosure, so that its gaseous contents shall move off, and be replaced by pure air, as freely, as rapidly, and as incessantly, as in the open atmosphere?

It happens to be the most necessary preliminary in approaching this problem, to show how *not* to do it, for that, respectfully be it spoken, is what we have hitherto practiced, as results abundantly prove. Fallacies, both vulgar and scientific, obstruct our way. A fundamental fallacy respects the very nature of the work, which is supposed to be to get in fresh air. In point of fact, this care is both unnecessary and comparatively useless. Take care of the bad air, and the fresh air will take care of itself. Only make room for it, and you cannot keep it out. On the other hand, unless you first make room for it, you cannot keep it in; pump it in and blow it in as you may, you only blow it through, as the Jordan flows comparatively uncontaminated through the Dead Sea. This is a law of fluids that must be kept in view. The pure air is quite as ready to get out as to get in; while the air loaded with poisonous vapors is as sluggish as a gorged serpent, and will not budge but on compulsion. Such compulsion the grand system of wind suction, actuated by the sun, supplies on the scale of the universe; and this we must imitate and adapt for our more limited purposes.

It would seem as if we need not pause to notice so shallow though common a notion as that which usually comes in right here, namely, that confined air will move off somehow of itself, if you give it liberty; being supposed to be much like a cat in a bag, wanting only a hole to make its escape. Air is ponderable matter—as much so as lead—and equally requires force of some kind to set it or keep it in motion. But applied philosophy itself relies on a fallacious, or, at best, inadequate source of motive power for ventilation. It gravely prescribes ventilating flues and even holes, and promises us that the warmed air within the house will rise through these flues and holes, carrying its impurities away with it, from the pressure of the cooler and denser air without. But we very well know that the best of flues and chimneys will draw only by favor of lively fires or clear weather. They fail us utterly when most needed, in warm and murky weather, when the barometer is low, and the thin atmosphere drops down its damp and dirty contents, burying us to the chimney tops in a pestilent congregation of vapors.

Nevertheless, so far as I can discover, these holes and flues, at best a little fire at the bottom of the latter, are the sole and all-sufficient expedients of science and architecture for ventilation to this day, in spite of their total failure in experience. I can find nothing in standard treatises or examples from philosophers or architects, beyond a theoretical calculation on so much expansion of air from so many units of heat, and hence so much ascensional force inferred in the ventilating flue—a result which never comes to pass, yet none the less continues to be cheerfully relied on. Unfortunately for the facts, they contradict the philosophy, and are only to be ignored with silent contempt. A French Academician's report on the ventilation of a large public building, lately reprinted by the Smithsonian Institution, states with absolute assurance and exactness the cubic feet of air changed per minute, with the precise volume and velocity of its ascension, by burning a peck of coal at the bottom of

the trunk flue. No mention is made of the anemometer or any other gauge of the result asserted, and we are left to the suspicion that it is merely a matter of theoretical inference, as usual; for every one who has had any acquaintance with practical tests in these matters knows that no such movement of air ever takes place under such conditions, unless by exceptional favor of the weather.

I have seen a tall steam boiler chimney induce through a four inch pipe a suction strong enough to exhaust the air from a large room as fast as perfect ventilation would require. But this, it is well known, requires four hundred or five hundred degrees of heat in the chimney. I never saw an ordinary domestic fire of coals produce any noticeable ventilating suction, without the use of a blower, urging the combustion to fury, and I presume nobody else ever did.

But, while nobody ever saw an active suction of air produced by the mere heat of a still or unexcited fire—unless the quantity of heat were on a very large scale—everybody has seen a roaring current sucked through the narrowed throat of a chimney or a stove by a blazing handful of shavings, paper, or straw. It is very remarkable, when you come to think of it, that the burning of an insignificant piece of paper, with less heat in it, perhaps, than a pea of anthracite, will cause a rush of air that a bushel of anthracite cannot in the least degree imitate. It is not only a curious but a most important fact. In short, it is the cardinal fact on which ventilation practically turns. But what is the nature of it? There are three factors in the phenomenon. In the first place, the mechanical peculiarity of flame, or gas in the moment of combustion, as compared with a gas like air merely heated, is an almost explosive velocity of ascent. The physical peculiarity from which this results is the intensity of its heat—commonly stated at 2,000 degrees, as to our common illuminating gas—acting instantaneously throughout its mass, just as in gunpowder. The gas goes up the flue in its own flash, like the ignited charge in the barrel of a gun: the burning coals can only send, and by a leisurely messenger, namely, the moderately heated gases, and contiguous air, that rise only by the gravitation or pressure of the surrounding atmosphere.

And yet it is not the small flame itself that roars in the chimney, but the rush of air induced by it. The semi-explosion of flame is but for an instant, though constantly renewed, and its explosive impulse cannot carry its light products of combustion very far through stationary and resistant air. It is the induction of air carried with it by such semi-explosive impulse (under proper mechanical conditions) that is strange to our observation and understanding, and is the second factor in the phenomenon we are accounting for and preparing to utilize.

The process, as it actually is, may be clearly exhibited by a very simple means. Let any one take a tube, say an inch in diameter—a roll of paper will do as well as anything—and, applying it closely to his mouth, try the whole force of his lungs through it upon any light object. The amount of effect will be found surprisingly small; and unless the tube is a short one, it will be so far absorbed by friction and atmospheric resistance as to be almost imperceptible. Then let him hold the same tube near to the mouth, but not in contact, and repeat the experiment. With the best adjustment, the effect may be described as tenfold or fifty-fold, or almost any fold—the effect of the simple blowing being merely nominal as compared with the induced current added by blowing into the tube instead of *at* it. The blast enters the free and open orifice with all the contiguous air which its surface friction and the vacuum of its movement can involve in its rolling vortex. While the entrance is thus crowded with pressure, the exit is free; and the result at the exit is a blast of well sustained velocity and magnified volume; ready itself to repeat the miracle on a still larger scale if provided with the apparatus for doing so. To test this, now place a second and larger tube in such position as to prolong the first in a straight line, but with a slight interval between the meeting ends; so that the blast, as magnified in volume in entering the first tube, may enter in like manner the second tube and be magnified again. With correct adjustments this experiment will prove more surprising than the first. Put on a third and still larger tube in the same way, and still larger surprise will meet a still larger volume and force of blast, like a stiff breeze set in motion by the puny effort of a single expiration. Of course, the prime impulse must bear a certain proportion to the result; and the inductive or tractional friction of the initial blast, of flame or breath, will be used up at length unless re-enforced. In ventilating practice, there is such re-enforcement, from an excess of gravity in the cooler atmosphere outside the flue in which the flame is operating with its heat as well as its ascensional traction; so that there has been found no limit to the extensions and fresh inductions that may be added to the first or trunk flue, with increase rather than diminution of power at every point. But the terms on which such extensions must be made have been referred to in our illustration, and must be accurately ascertained and observed. They constitute what is, in effect, the third factor in the phenomenon of a roaring draught, and also, therefore, in effective ventilation. That is, the entering or induced current of air must always find its channel of progress and exit certain correct degrees larger than the opening by which it entered. Every one knows that a stove or chimney wide open admits of but little suction in connection with even the blaze of paper or shavings.

The mobility of air seems almost preternatural, when the proper conditions for setting a current in motion are supplied. But without a current established, it is surprising in turn to find how obstinately and elusively immovable it can be. It is like tossing a feather; or trying to drive a swarm of flies; dodging and evading every impulse applied. But, given a flue, to define and conduct a stream; an upright flue, to take advantage of the slighter gravity of the warmed air within it; and a flue contracted at the inlet and expanded as it rises, so as to free, diffuse, and lighten the column of air, toward the exit; then, initiate an induced current of air at the inlet, by the injection of a jet of gas in the state of semi-explosive action called flame; the pressure pushing upward from the crowded entrance finds easier way and less resistance the farther it goes in the expanding flue; the warmth and reduced gravity of the stream comes in as an auxiliary in overcoming friction and any exceptional obstruction in the state of the atmosphere; and now, as the ball is once set rolling, with a little aid instead of resistance from gravitation, its initial impulse all the while sustained by the gas jet, and friction reduced to a very small incident—there is nothing to prevent the current rolling on with accelerated velocity (within the limitations imposed by increasing friction) and rolling on forever. I might, if I had time, add a curious consideration of the law of vortex motion in elastic fluids, demonstrated by Helmholtz, which relieves the motion of such fluids from friction, as wheels facilitate the movement of a solid; and which also sucks into the rolling vortex the

contiguous air, thus entraining it, as we have seen, so much more effectively than could be done by a direct and rigid current, like a jet of water, for instance. A wheel set in motion on an almost frictionless bearing of metalline, runs without perceptible abatement of velocity, until one begins to involuntarily question whether it will ever stop. In the all but free winds that roll with minimized friction in the higher atmosphere, there seems to be a self-moving force; so persistent is simple momentum in a mass so infinitesimally obstructed and so infinitely wheeled. An active current of air in a ventilating flue is only less perfect in the same conditions; and so it is quite conceivable, and not incredible, that such a current may be gradually established and thenceforward permanently maintained by a small motor flame barely more than enough to overbalance the minimized friction. This is not a supposed or theoretically inferred fact, like the facts of ventilation sometimes alleged by theorists. On the contrary, the theory I have offered is merely an attempt to explain facts that I have witnessed and that any one can verify with the anemometer. But the theory by no means covers the art and mystery of ventilation; for ventilation is truly an art as well as a mystery. The art lies in a consummate experience of the sizes, proportions, and forms of flues, their inlets, expansions, and exits, with many other incidental adaptations necessary, in order to insure under all circumstances the regular exhaustion of any specific volume of air required, per minute. And this art has by one man been achieved. It would be a double injustice if I should neglect from any motive to inform my audience to whom I am indebted for what I know about ventilation practically, and even for the knowledge that there is any such fact as a practicable ventilation of houses; one who is no theorist, but who has felt his way experimentally with his own hands, for a lifetime, to a practical mastery of the art to which I have attempted to fit a theory; every one present who is well informed on this subject must have anticipated already in mind the name of Henry A. Gouge.

THE RECENT ERUPTION OF ETNA.

On the morning of the 20th of March, a long series of earthquakes spread alarm throughout all the cities and numerous villages that are scattered over the sides of Mt. Etna. The shocks followed each other at intervals of a few minutes; dull subterranean rumblings were heard; and a catastrophe was seen to be impending. Toward evening the ground cracked at the lower part of the south side of the mountain, at the limit of the cultivated zone, and at four kilometers to the north of the village of Nicolosi. There formed on the earth a large number of very wide fissures, through which escaped great volumes of steam and gases which enveloped the mountain in a thick haze; and toward night, a very bright red light, which, seen from Catania, seemed to come out in great waves from the foot of the mountain, announced the coming of the lava.

Eleven eruptions occurred during the night, and shot into the air fiery scoriae which, in a short time, formed three hillocks from forty to fifty meters in height. The jet of scoriae was accompanied with strong detonations, and the oscillations of the ground were of such violence that the bells in the villages of Nicolosi and Pedara rang of themselves. The general consternation was the greater in that the locality in which the eruptive phenomena were manifesting themselves was nearly the same as that which formed the theater of the celebrated eruption of 1669. This locality overlooks an inclined plane which is given up to cultivation, and in which are scattered, at a short distance from the place of the eruption, twelve villages having a total population of 20,000 inhabitants. On the second day the character of the eruption had become of a very alarming character. New fissures showed themselves up to the vicinity of Nicolosi, and the lava flowed in great waves over the circumjacent lands. This seemed to indicate a lengthy eruption; but, to the surprise of those interested in volcanic phenomena, on the third day the eruptive movement began to decrease, and, during the night, stopped entirely. This was a very fortunate circumstance, for this eruption would have caused immense damages. It cannot be disguised, however, that the eruptive attendants of this conflagration remain under conditions such as to constitute a permanent danger for the neighboring villages. It has happened, in fact, that in consequence of the quick cessation of the eruption, those secondary phenomena through which nature usually provides a solid closing of the parasitic craters have not occurred. So it is probable that when a new eruption takes place it will be at the same point at which manifested itself the one that has just abated.—*La Nature*.

PHYSICS WITHOUT APPARATUS.

TAKE an ordinary wine bottle and place it in front of and within a few inches of a lighted candle. Blow against the bottle with your mouth at about four or six inches distant from it and in a line with the flame. Very curiously, notwithstanding the presence of the bottle and its interception of the current of air, the candle will be immediately extinguished as if there were no obstacle in the way. This phenomenon is readily understood when we reflect that the bottle receives the current of air on its polished surface and divides it into two, one of which is guided to the right and the other to the left. These two currents, after separating and driving back the surrounding air, meet again at the very spot at which the flame is situated, and extinguish the candle.



MODE OF EXTINGUISHING A CANDLE PLACED BEHIND A BOTTLE.

It is evident that the experiment can be reproduced by putting the candle behind a stove pipe, a cylinder of glass or metal, a cylindrical tin box, or any other object of the same form with a diameter greater than that of a bottle, but not having a rough or angular surface, since the latter would cause the current to be lost in the surrounding air.

THE TRAVELS OF THE SUN.

SOME recent discussions of the constitution of the sun have turned in part upon what is known as the sun's proper motion in space. This is one of the most surprising and interesting things that science has ever brought to light, and yet it is something of which comparatively few persons have any knowledge. It is customary to look upon the sun as if it were the center of the universe, an immovable fiery globe around which the earth and other planets revolve while it remains fixed in one place. Nothing could be further from the truth. The sun is, in fact, the most wonderful of travelers. He is flying through space at the rate of not less than a hundred and sixty millions of miles in a year, and the earth and her sister planets are his fellow voyagers, which, obeying his overpowering attraction, circle about him as he advances. In other words, if we could take up a position in open space in advance of the sun, we should see him rushing toward us at the rate of some 450,000 miles a day, chased by his whole family of shining worlds and the vast swarms of meteoric bodies which obey his attraction.

The general direction of this motion of the solar system has been known since the time of Sir William Herschel. It is toward the constellation Hercules, which, at this season, may be seen in the northeastern sky at 9 o'clock in the

evening. As the line of this motion makes an angle of fifty odd degrees with the plane of the earth's orbit, it follows that the earth is not like a horse at a windlass, circling around the sun forever in one beaten path, but like a ship belonging to a fleet whose leader is continually pushing its prow into unexplored waters.

The path of the earth through space is spiral, so that it is all the time advancing into new regions along with the sun. She is on a boundless voyage of discovery, and her human crew are born and die in widely separated tracts of space. Think of the distance over which the travels of the sun have borne the earth only since the beginning of human history! Six thousand years ago the earth and sun were about a million millions of miles further from the stars in Hercules than they are to-day. Columbus and his contemporaries lived when the earth was in a region of the universe more than sixty thousand millions of miles from the place where it is now, so that since his time the whole human race has been making a voyage through space, in comparison with which his longest voyage was as the footprint of a fly.

Thus the great events in the history of the world may be said to have occurred in different parts of the universe. An almost inconceivable distance separates the spot which the earth occupied in the time of Alexander from that which it occupied when Caesar invaded Gaul. The sun and the earth have wandered so far from their birthplace that the mind staggers in the attempt to guess at the stupendous distance which now probably separates them from it. It may be that the motion of the solar system is orbital and that our sun and many of the stars, his fellow suns, are revolving around some common center, but if so, no means has yet been devised of detecting the form or dimensions of his orbit. So far as we can see, the sun is moving in a straight line.

Since space is believed to be filled with some sort of ethereal medium, curious consequences are seen to follow from the motions that have been described. A solid globe like the earth rushing at great speed through such a medium will encounter some resistance. If the medium be exceedingly rare, as it must be in fact, the resistance will be correspondingly small, but still there will be resistance. If the sun stood still, the earth, owing to the inclination of its axis to the plane of its orbit around the sun, would encounter the resistance of the ether principally on its northern hemisphere from summer to winter, and on its southern hemisphere from winter to summer. But in consequence of the motion of the sun shared by the earth, this law of distribution is changed, and from summer to winter the earth plows through the ether with its north pole foremost, while from winter to summer, although the resistance of the ether is encountered more evenly by the two hemispheres, yet it is still felt principally in the northern hemisphere, and the south pole remains practically protected. It follows that the southern hemisphere, and particularly the south polar regions are more or less completely sheltered the whole year around. It might then be supposed that the impact of the particles of the ether shouldered aside by the earth in its swift flight and the compression produced in front of the advancing globe would tend to raise the temperature of the northern hemisphere as compared with the southern hemisphere, while the south pole, being more or less directly in the wake of the earth, and in a region of rarefaction of the ether, would constantly possess a remarkably low temperature.

Now, it is known that the south polar regions are more covered with ice and snow than those of the north, and that the temperature there the year around is lower. Whether this difference is owing to the effects of the earth's journey through the ether, is a question.

The sun, too, moves with his northern hemisphere foremost, and it is worthy of remark that it has been suspected that the northern hemisphere of the sun radiates more heat than the southern.

But whatever effect it may or may not have upon the meteorological condition of the earth, the fact that the solar system is thus voyaging through space is in itself exceedingly interesting. Not the wildest traveler's dream presents to the imagination such a voyage as this on which every inhabitant of the earth is bound. A glance at a star map shows that the direction in which we are going is carrying us toward a region of the heavens exceedingly rich in stars, many, and perhaps most, of which are greater suns than ours. There can be little doubt that when the sun arrives in the neighborhood of those stars, he will be surrounded by celestial scenery very different from and much more brilliant than that of the region of space in which he now is. The inhabitants of the globe at that distant period will certainly behold new and far more glorious heavens, though the earth may be unchanged.—*N. Y. Sun*.

PROPAGATION OF MAPLE TREES.

I do not presume that all people over three score years of age are so entirely ignorant as I am, but probably there are some. I have lived more than sixty years almost in the woods, and I never observed, and never heard any other person speak of, the blooming, seeding, and maturing of the water maple. I have a beautiful row of water maple shade trees along the street in front of my house. In March, 1882, I observed that they were in bloom, and many bees were swarming about them. After the bees left them I noticed the seed (specimens inclosed of this spring's growth) in millions. As the leaves put out in April the little knife blade seeds fell off, so thick as to almost cover the ground. My grandson picked up three or four hatfuls, and I sent the seed to my farm and had them drilled in like wheat, when I planted corn. The result is I have from 300 to 500 beautiful maples from 6 inches to three feet high. I noticed the blooms again this spring, but a cold snap killed the blooms, and only now and then can I find a seed. I had a sugar tree in my yard, which bloomed and bore seed which did not fall off through the summer. My yard now has as many little sugar trees as it has leaves of blue grass.

It strikes me that the gathering and planting of maple seed is the best way to wood the prairies of the West and the worn-out lands of the Eastern and Middle States. The tree is valuable for shade and for timber, and is as rapid in growth as any tree within my knowledge. I noticed some trees of this sort yesterday which are from 2½ to 3½ feet in diameter. The lumber from such timber makes beautiful furniture. This is intended only for those who have been as non-observant as myself, and not the wise, who are always posted. Franklin, Tenn. J. B. M.

The seeds inclosed were the samaras of *Acer rubrum*, called the "soft" maple in many localities, and "red" maple in others. We have seen trees only three or four inches in diameter full of blossoms. This is one of the earliest trees to bloom in spring, and the pretty winged samaras soon mature and fall. The sugar maple, *Acer saccharinum*, blossoms later, and the seeds are persistent till autumn, and lie on the

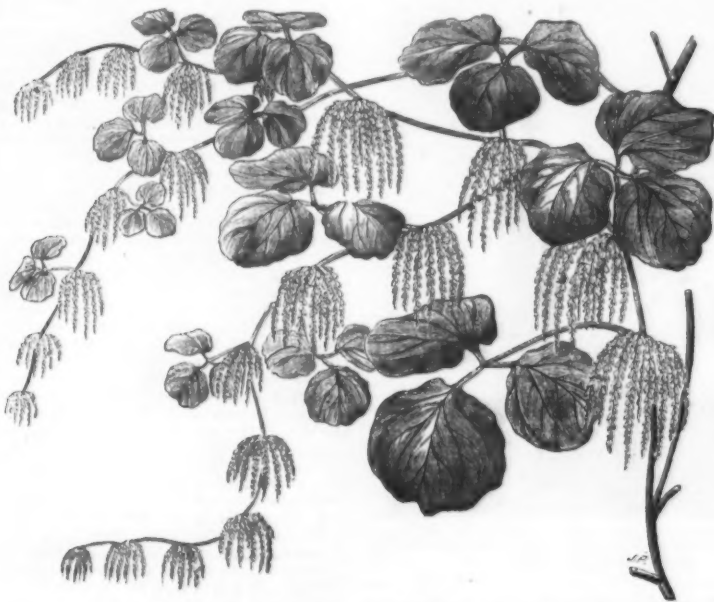


1.—PLACE OF THE ERUPTION. 2.—MONTI ROSSI. 3.—VILLAGE OF NICOLOSI.
ERUPTION OF MOUNT ETNA, MARCH 22, 1883.

ground all winter before germinating. The lumber from this latter is more valuable than soft maple, being harder, heavier, and taking a better polish. Soft maple makes an ox-yoke which is durable and not heavy. In early times a decoction of the bark was frequently used for making a black ink.—*Country Gentleman*.

DIOSCOREA RETUSA.

ONE of the most elegant plants one can have in a greenhouse is this twiner, a native of South Africa. It has slender stems clothed with distinctly veined leaves, and produces a profusion of creamy white fragrant flowers in pendulous clusters, as shown in the annexed engraving, for which we are indebted to Messrs. Veitch, of Chelsea, who distributed the plant a few years ago. On several occasions Messrs. Veitch have exhibited it trained parasol fashion and covered abundantly with elegant drooping clusters of flowers, and as such it has been much admired. When planted out in a warmish greenhouse and allowed to twine at will around an



FLOWERING SPRAY OF DIOSCOREA RETUSA.

upright pillar, it is seen to the best advantage, and, though not showy, makes a pleasing contrast with other gayly tinted flowers. It is so unlike any other ornamental plant in cultivation, that it ought to become more widely known than it appears to be at present.—*The Garden*.

RAVAGES OF A RARE SCOLYTID BEETLE IN THE SUGAR MAPLES OF NORTHEASTERN NEW YORK.

ABOUT the first of last August (1892) I noticed that a large percentage of the undergrowth of the sugar maple (*Acer saccharinum*) in Lewis County, Northeastern New York, seemed to be dying. The leaves dropped and withered, and finally shriveled and dried, but still clung to the branches.

The majority of the plants affected were bushes a centimeter or two in thickness, and averaging from one to two meters in height, though a few exceeded these dimensions. On attempting to pull them up they uniformly, and almost without exception, broke off at the level of the ground, leaving the root undisturbed. A glance at the broken end sufficed to reveal the mystery, for it was perforated, both vertically and horizontally, by the tubular excavations of a little Scolytid beetle which, in most instances, was found still engaged in his work of destruction.

At this time the wood immediately above the part actually invaded by the insect was still sound, but a couple of months later it was generally found to be rotten. During September and October I dug up and examined a large number of apparently healthy young maples of about the size of those already mentioned, and was somewhat surprised to discover that fully ten per cent. of them were infested with the same beetles, though the excavations had not as yet been sufficiently extensive to affect the outward appearance of the bush. They must all die during the coming winter, and next spring will show that, in Lewis County alone, hundreds of thousands of young sugar maples perished from the ravages of this Scolytid during the summer of 1892.

Dr. George H. Horn, of Philadelphia, to whom I sent specimens for identification, writes me that the beetle is *Corthylus punctatissimus*, Zim., and that nothing is known of its habits. I take pleasure, therefore, in contributing the present account, meager as it is, of its operations, and have illustrated it with a few rough sketches that are all of the natural size, excepting those of the insects themselves, which are magnified about nine diameters.

The hole which constitutes the entrance to the excavation is, without exception, at or very near the surface of the ground, and is invariably beneath the layer of dead and decaying leaves that everywhere covers the soil in our Northern deciduous forests. Each burrow consists of a primary, more or less horizontal, circular canal, that passes completely around the bush, but does not perforate into the entrance hole, for it generally takes a slightly spiral course, so that when back to the starting point it falls either a little above, or a little below it—commonly the latter (see Figs. 1 and 2).

It follows the periphery so closely that the outer layer of growing wood, separating it from the bark, does not average 0.25 mm. in thickness, and yet I have never known it to cut entirely through this, so as to lie in contact with the bark.

From this primary circular excavation issue, at right angles, and generally in both directions (up and down), a varying number of straight tubes, parallel to the axis of the plant (see Figs. 1, 2, and 3). They average five or six millimeters in length, and commonly terminate blindly, a mature

beetle being usually found in the end of each. Sometimes, but rarely, one or more of these vertical excavations is found to extend farther, and, bending at a right angle, to take a turn around the circumference of the bush, thus constituting a second horizontal circular canal from which, as from the primary one, a varying number of short vertical tubes branch off. And in very exceptional cases these excavations extend still deeper, and there may be three, or even four, more or less complete circular canals. Such an unusual state of things exists in the specimen from which Fig. 3 is taken.

It will be seen that with few exceptions, the most important of which is shown in Fig. 4, all the excavations (including both the horizontal canals and their vertical off-

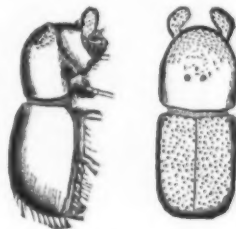


FIG. 5.—*Corthylus punctatissimus*.

shoots) are made in the sap-wood immediately under the bark, and not in the hard and comparatively dry central portion. This is, doubtless, because the outer layers of the wood are softer and more juicy, and therefore more easily cut, besides containing more nutriment and being, doubtless, better relished than the drier interior.

This beetle does not bore, like some insects, but devours bodily all the wood that is removed in making its burrows. The depth of each vertical tube may be taken as an index to the length of time the animal has been at work; and the number of these tubes generally tells how many inhabit each bush, for as a general rule each individual makes but one hole, and is commonly found at the bottom of it. All of the excavations are black inside.



FIGS. 1 AND 2.—Mines of *Corthylus punctatissimus*.



FIGS. 3 AND 4.—Mines of *Corthylus punctatissimus*.

The beetle is sub-cylindric in outline, and very small, measuring but 3.5 mm. in length. Its color is a dark chestnut brown, some specimens being almost black. Its head is bent down under the thorax, and cannot be seen from above (see Fig. 5).

Should this species become abundant and widely dispersed, it could but exercise a disastrous influence upon the maple forests of the future.—*C. Hart Merriam, M.D., in American Naturalist*.

THE RED SPIDER.

(*Tetranychus telarius*.)

THE red spider is not correctly speaking an insect, though it is commonly spoken of as such, neither is it a spider, as its name would imply, but an acarid or mite. Whether its name is correct or not, it is a most destructive and troublesome pest wherever it makes its presence felt; it by no means confines itself to one or only a few kinds of plants, as many insects do, but it is very indiscriminate in its choice of food, and it attacks both plants grown under glass and those in the open air. When these pests are present in large numbers, the leaves on which they feed soon present a sickly yellow or scorched appearance, for the supply of sap is drawn off by myriads of these little mites, which congregate on the under sides of the leaves, where they live in a very delicate web, which they spin, and multiply very rapidly; this web and the excrement of the red spider soon choke up the pores of the leaves, which, deprived of their proper amount of sap, and unable to procure the carbon from the atmosphere which they so much need, are soon in a sorry plight. However promiscuous these mites may be in their choice of food plants—melons, cucumbers, kidney beans, hops, vines, apple, pear, plum, peach trees, limes, roses, laurustinus, cactuses, clover, ferns, orchids, and various stove and greenhouse plants being their particular favorites—they are by no means insensible to the difference between dryness and moisture. To the latter they have a most decided objection, and it is only in warm and dry situations that they give much trouble, and it is nearly always in dry seasons that plants, etc., out of doors suffer most from these pests. Fruit trees grown against walls are particularly liable to be attacked, since from their position the air round them is generally warm and dry, and the cracks and holes in the walls are favorite places for the red spider to shelter in, so that extra care should be taken to prevent them from being infested; this may best be effected by syringing the trees well night and morning with plain water, directing the water particularly to the under sides of the leaves, so as, if possible, to wash off the spiders and their webs. If the trees be

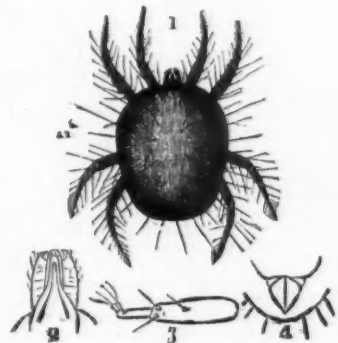


FIG. 1.—Red Spider (magnified). A 1. Ditto (natural size). 2. Underside of head. 3. Foot. 4. Spinneret.

already attacked, adding soft soap and sulphur to the water will destroy them.

Sulphur is one of the most efficient agents known for killing them; but it will not, however, mix properly with water in its ordinary form, but should be treated according to the following recipe:

Boil together in four gallons of water 1 lb. of flowers of sulphur and 2 lb. of fresh lime, and add 1½ lb. of soft soap, and, before using, 3 gallons more of water; or mix 4 oz. of sulphate of lime with half that weight of soft soap, and, when well mixed, add 1 gallon of hot water. Use when cool enough to bear your hand in it. Any insecticide containing sulphur is useful. The walls should be well washed with some insecticide of this kind. Old walls in which the pointing is bad and the bricks full of nail holes, etc., are very difficult to keep free from red spider. They should be painted over with a strong solution of soft water mixed with clay to form a paint. To a gallon of this paint add 1 lb. of flowers of sulphur and 2 oz. of soft soap.

This mixture should be thoroughly rubbed with a brush into every crack and crevice of the walls, and if applied regularly every year would probably prevent the trees from being badly attacked. As the red spider passes the winter under some shelter, frequently choosing stones, rubbish, etc., near the roots of the trees, keeping the ground near the trees clean and well cultivated will tend greatly to diminish their numbers. In vineries one of the best ways of destroying these creatures is to paint the hot water pipes with one part of fresh lime and two parts of flowers of sulphur mixed into a paint. If a flue is painted in this way, great care should be taken that the sulphur does not burn, or much damage may be done, as the flues may become much hotter than hot water pipes. During the earlier stages of growth keep the atmosphere moist and impregnated with ammonia by a layer of fresh stable litter, or by painting the hot water pipes with guano made into a paint; as long as the air in the house is kept moist there is not much danger of a bad attack. As soon as the leaves are off, the canes should be dressed with the recipe already given for painting the walls, and two inches or so of the surface soil removed and replaced with fresh, and all the wood and iron work of the house well scrubbed. If carnations are attacked, tying up some flowers of sulphur in a muslin bag and sulphuring the plants liberally, and washing them well in three days' time has been recommended.

Tobacco water and tobacco smoke will also kill these pests, but as neither tobacco nor sulphuring the hot water pipes can always be resorted to with safety in houses, by far the better way is to keep a sharp look-out for this pest, and as soon as a plant is found to be attacked to at once clean it with an insecticide which it is known the plant will bear, and by this means prevent other plants from being infested.

These little mites breed with astonishing rapidity, so that great care should be exercised in at once stopping an attack. A lady friend of mine had some castor oil plants growing in pots in a window which were badly attacked, and found that some lady-birds soon made short work of the mites and cleared the plants. The red spider lays its eggs among the threads of the web which it weaves over the under sides of the leaves; the eggs are round and white; the young spiders are hatched in about a week, and they very much resemble their parents in general appearance, but they have only three pairs of legs instead of four at first, and they do not acquire the fourth pair until they have changed their skins several times; they are, of course, much smaller in size, but are, however, in proportion just as destructive as the older ones. They obtain the juices of the leaves by eating through the skin with their mandibles, and then thrusting in their proboscis or suckers (Fig. 2), through which they draw out the juices. These little creatures are so transparent, that it is very difficult to make out all the details of their mouths accurately. The females are very fertile, and breed with great rapidity under favorable circumstances all the year round.

The red spiders, as I have already stated, are not real spiders, but belong to the family Acarina or mites, a family included in the same class (the arachnida) as the true spiders, from which they may be easily distinguished by the want of any apparent division between the head and thorax and body; in the true spiders the head and thorax are united together and form one piece, to which the body is joined by a slender waist. The arachnida are followed by the myriapoda (centipedes, etc.), and these by the insecta or true insects. The red spiders belong to the kind of mites called spinning mites, to distinguish them from those which do not form a web of any kind. It is not quite certain at present whether there is only one or more species of red spider; but

that it is an exception to all known lizards in that its teeth are poison fangs comparable with those of venomous serpents.

Speaking of the Mexican reputation of the lizard, in a recent issue of *Knowledge*, Dr. Andrew Wilson, whose opinion will be respected by all naturalists, says that "without direct evidence of such a statement no man of science, basing his knowledge of lizard nature on the exact knowledge to hand, would have hesitated in rejecting the story as, at least, improbable. Yet it is clear that the stories of the New World may have had an actual basis of fact; for the *Heloderma horridum* has been, beyond doubt, proved to be poisonous in as high a degree as a cobra or a rattlesnake."

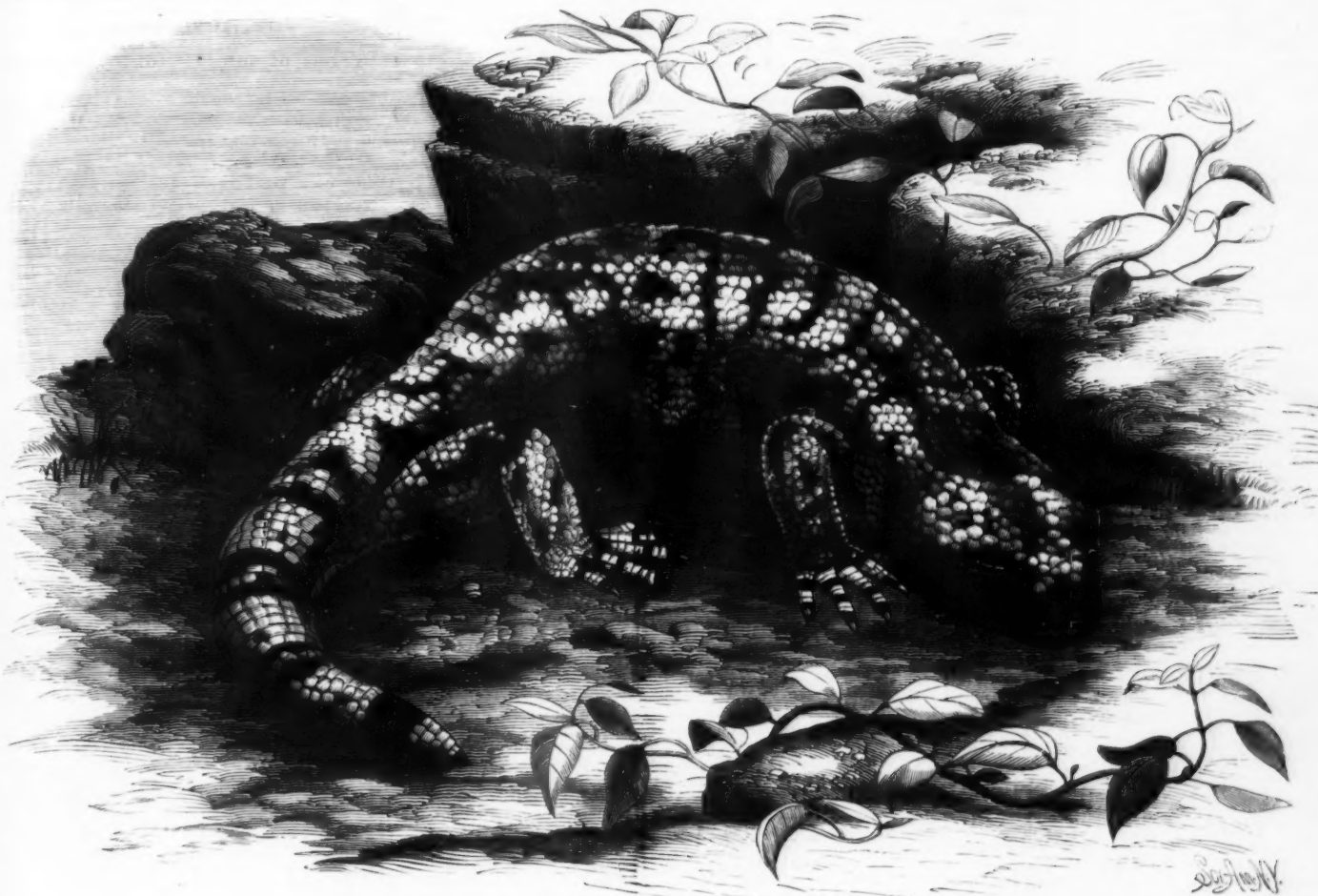
"At first the lizard was freely handled by those in charge at Regent's Park, and being a lizard, was regarded as harmless. It was certainly dull and inactive, a result probably due to its long voyage and to the want of food. Thanks, however, to the examination of Dr. Gunther, of the British Museum, and to actual experiment, we now know that *Heloderma* will require in future to be classed among the deadly enemies of other animals. Examining its mouth, Dr. Gunther found that its teeth formed a literal series of poison fangs. Each tooth, apparently, possesses a poison gland; and lizards, it may be added, are plentifully supplied with these organs as a rule. Experimenting upon the virulence of the poison, *Heloderma* was made to bite a frog and a guinea pig. The frog died in one minute, and the guinea-pig in three. The virus required to produce these effects must be of singularly acute and powerful nature. It is to be hoped that no case of human misadventure at the teeth of *Heloderma* may happen. There can be no question, judging from the analogy of serpent-bite, that the poison of the lizard would affect man."

not killed, but the limb became swollen, and the cat continued mewing for several hours, as if in extreme pain. The dead specimens sent to Europe have been carefully examined as to the character of the teeth. Sections of these have been made, which demonstrate the existence of a canal in each, totally distinct from and anterior to the pulp cavity; but the soft parts had not been examined with sufficient care to determine the existence or non-existence of any poison gland in immediate connection with these perforated teeth until Dr. Gunther's observations were made, as described by Dr. Wilson.

Hitherto, as noted in a previous article, American naturalists have regarded the heloderm as quite harmless—an opinion well sustained by the judgment of many persons in Arizona and other parts of the West by whom the reptile has been kept as an interesting though ugly pet. While the Indians and native Mexicans believe the creature to be venomous, we have never heard an instance in which the bite of it has proved fatal.

A correspondent of the *SCIENTIFIC AMERICAN*, "C. E. J.," writing from Salt Lake City, Utah, under date of September 8, says, after referring to the article on the heloderm in our issue of August 26:

"Having resided in the southern part of this Territory for seventeen years, where the mercury often reaches 110° or more in the shade, and handled a number of these 'monsters,' I can say that I never yet knew anybody or anything to have perished from their bite. We have often had two or three of them tied in the door-yard by a hind leg, and the children have freely played around them—picking them up by the nape of the neck and watching them snap off a small bit from the end of a stick when poked at them. We have fed them raw egg and milk; the latter they take with great relish. At one time a small canine came too near the mouth



THE HELODERMA HORRIDUM, OR GILA MONSTER.

this is immaterial to the horticulturist, as their habits and the means for their destruction are the same. The red spider (*Tetranychus telarius*—Fig. 1) is very minute, not measuring more than the sixtieth of an inch in length when full grown; their color is very variable, some individuals being nearly white, others greenish, or various shades of orange, and red. This variation in color probably depends somewhat on their age or food—the red ones are generally supposed to be the most mature. The head is furnished with a pair of pointed mandibles, between which is a pointed beak or sucker (Fig. 2). The legs are eight in number; the two front pairs project forward and the other two backward; they are covered with long stiff hairs; the extremities of the feet are provided with long bent hairs, which are each terminated by a knob. The legs and feet appear to be only used in drawing out the threads and weaving the web. The thread is secreted by a nipple or spinneret (Fig. 4) situated near the apex of the body on the under side. The upper surface of the body is sparingly covered with long stiff hairs.—*G. S. S., in The Garden.*

THE HELODERMA HORRIDUM.

The discussion of the curious lizard found in our Western Territories and in Mexico, and variously known as the "Montana alligator," "the Gila monster," and "the Mexican heloderma," is becoming decidedly interesting.

As noted in a recent issue of the *SCIENTIFIC AMERICAN*, a live specimen was sent last summer to Sir John Lubbock, and by him presented to the London Zoological Gardens. At first it was handled as any other lizard would be, without special fear of its bite, although its mouth is well armed with teeth. Subsequent investigation has convinced its keepers that the creature is not a fit subject for careless handling; that its native reputation is justified by fact; and

In an article in the *London Field*, Mr. W. B. Tegetmeier states that this remarkable lizard was first described in the *Zoö*, in 1829, by the German naturalist Wiegmann, who gave it the name it bears, and noted the ophidian character of its teeth.

In the *Comptes Rendus* of 1875, M. F. Sumichrast gave a much more detailed account of the habits and mode of life of this animal, and forwarded specimens in alcohol to Paris, where they were dissected and carefully described. The results of these investigations have been published in the third part of the "Mission Scientifique au Mexique," which, being devoted to reptiles, has been edited by Messrs. Aug. Dumeril and Becourt.

The heloderm, according to M. F. Sumichrast, inhabits the hot zone of Mexico—that intervening between the high mountains and the Pacific in the districts bordering the Gulf of Tehuantepec. It is found only where the climate is dry and hot; and on the moister eastern slopes of the mountain chain that receive the damp winds from the Gulf of Mexico it is entirely unknown. Of its habits but little is known, as it appears to be, like many lizards, nocturnal, or seminocturnal, in its movements, and, moreover, it is viewed with extreme dread by the natives, who regard it as equally poisonous with the most venomous serpents. It is obviously, however, a terrestrial animal, as it has not a swimming tail flattened from side to side, nor the climbing feet that so characteristically mark arboreal lizards. Sumichrast further states that the animal has a strong nauseous smell, and that when irritated it secretes a large quantity of gluey saliva. In order to test its supposed poisonous property, he caused a young one to bite a pullet under the wing. In a few minutes the adjacent parts became violet in color, convulsions ensued, from which the bird partially recovered, but it died at the expiration of twelve hours. A large cat was also caused to be bitten in the foot by the same heloderm; it was

of our alligator (*mountain alligator*, we call them), when it instantly caught the pup by the under jaw and held on as only it could (they have a powerful jaw), nor would it release its hold until choked near to death, which was done by taking it behind the bony framework of the head, between the thumb and finger, and pressing hard. The pup did considerable howling for half an hour, by which time the jaw was much swollen, remaining so for two or three days, after which it was all right again. By this I could only conclude that the animal was but slightly poisonous. I never knew of a human being having been bitten by one. My sister kept one about the house for several weeks, and fed it from her hands and with a spoon. The specimens have generally been sent (through the Desert Museum) to colleges and museums in the East.

"The Indians have a great fear that these animals produce at will good or bad weather, and will not molest them. Many times they have come to see them, and told us that we should let them go or they would talk to the storm spirit and send wind and water and fire upon us. An old Indian I once talked with told me of another who was bitten on the hand, and said it swelled up the arm badly, but he recovered. From some reason we never find specimens less than 12 or 14 inches long. I never saw a young one. There is a nice stuffed specimen, 18 inches long, in our museum here."

Sir John Lubbock's specimen, shown in the engraving herewith, for which we are indebted to the London *Field*, is about 19 inches in length. Its general color is a creamy buff, with dark brown markings. The forehead of the head and muzzle is entirely dark, the upper eyelid being indicated by a light stripe. The entire body is covered with circular warts. It is fed upon eggs, which it eats greedily.

It would be interesting to know whether the northern specimens, if venomous at all, are as fully equipped with

poison bags and fangs as Dr. Gunther finds the Mexican specimen to be. Some of our Western or Mexican readers may be able to make comparative tests. Meantime it would be prudent to limit the use of the "monster" as a children's pet.

The foregoing appeared in the SCIENTIFIC AMERICAN of Oct. 7, 1882.

We are now indebted to a correspondent, Mr. Wm. Y. Beach, of the Grand View Mine, Grant County, Southern Arizona, for a fine specimen of this singular reptile, just received alive. The example sent to us is about twenty inches long, and answers very well to the description of the monster and the engraving above given.

In the course of an hour after opening the box in which the reptile had been confined during its eight days' journey by rail, it became very much at home, stretching and crawling about our office floor with much apparent satisfaction.

Our correspondent is located in the mountains, some nine miles distant from the Gila River. He states that the reptile he sends was found in one of the shops pertaining to the mine, which had been left unoccupied for a week or so.

Appropos to the foregoing, we have received the following letter from another correspondent in Arizona:

To the Editor of the Scientific American:

My attention has been called to an article in your issue of Oct. 7, 1882, relating to the *Heloderma horridum*, or commonly known as the Gila Monster.

During a residence of ten years in Arizona I have had many opportunities of learning the habits of these reptiles, and I am satisfied their bite will produce serious effects, if not death, of the human race. I know of one instance where a gentleman of my acquaintance by the name of Bostick, at the Tigua Top mining camp, in Arizona, was bitten on the fingers, and suffered all the symptoms of poison from snake bite. He was confined to his bed for six weeks and subsequently died. I am of the opinion his death was in part caused by the effects of the poison of the Gila Monster.

The Hualar Indians are very much afraid of them, and one I showed the picture of the Monster in your paper remarked, "Chinamuck," which in Hualar language means "very bad." He said if an Indian is bitten, he sometimes dies.

I have seen them nearly two feet in length. Never, to my knowledge, are they kept as pets in our portion of Arizona. They live on mice and other small animals, and when aggravated can jump several times their length.

W. E. DAY, M.D.

Huckberry, Mahone Co., Ar. T., April, 1883.

THE KANGAROO.

To the Editor of the Scientific American:

In page 69 of your issue of 3d of February, 1883, I notice among the "Challenger Notes" of Professor Mosely the statement that "Among stockmen, and even some well educated people in Australia, there is a conviction that the young kangaroo grows out as a sort of bud on the teat of the mother within the pouch." Some eighteen months ago I noticed a paragraph wherein some learned professor was reported to have set at rest the contested point as to whether the kangaroo came into being in the same manner as the calves of the cow and other mammals, or whether the young grows, as alleged, upon the teat of its dam within the pouch. The learned professor in question asserted that it did not so grow upon the teat; but, with all due respect to the professor's claim to credibility on other matters, I must in this instance take the liberty of stating that he is in error. The young kangaroo actually comes out, if I may use such an expression, from the teat. Strange as the statement may seem, it is a fact that the first indication of life on the part of the kangaroo offspring is a very slight eruption, in size not larger than an ordinary pin head. This growth gradually resolves itself into the form of the marsupial, and is not detached until close upon the expiring of the fourth month. It is carried by the mother during that period, and thenceforth exists partially at least on herbage. Indeed, from the fourth till the seventh month it is almost constantly in the pouch, only coming out occasionally toward the close of evening to crop the grass. I had at one time in my possession a specimen of the kangaroo germ which I cut from off the teat, complete in form, whose entire weight was less than an ounce; and, at the same time, I had a kangaroo in my possession which measured seven feet six inches from the top of the ears to the extremity of the tail.

Your readers would doubtless feel interested with a few particulars as to my life among the kangaroos in a genuine kangaroo country. I have read somewhere about the exceeding beauty of the eyes of the gazelle; how noted hunters have alleged that their nature so softened on looking into the animal's eyes that they (the hunters) had no heart to destroy the creature. Now, I have never seen a gazelle, and so cannot indulge in comparisons; but if their eyes are more beautiful than those of a middle-aged kangaroo, they may indeed be all that hunters say of them. With respect to the old kangaroos, their eyes and face are simply atrocious in their repulsive ugliness.

Nothing in nature could surpass the affection which the female kangaroo manifests for her young. There is something absolutely touching in the anxious solicitude displayed by the dam while the young ones are at play. On the least alarm the youngster instantly ensconces himself in the pouch of his gentle mother, and should he, in the exuberance of his joy, thrust his head out from his place of refuge, it is instantly thrust back by his dam. I have, on several occasions, by hard riding, pressed a doe to dire extremity, and it has only been when hope had entirely forsaken her, or when her capture was inevitable, that she has reluctantly thrown out the fawn. Their method of warfare has often reminded me of the style of two practiced pugilists, the aim of each being to firmly gripe his opponent by the shoulder, upon accomplishing which, the long hind leg, with its horny blade projecting from its toe, comes into formidable play. It is lifted and drawn downward with a rapid movement, and one or other of the combatants soon shows the entrails laid bare, which is usually the grand finale. The sparring that takes place between the marsupials while trying to get the advantageous gripe is marvelous—I had almost said scientific; for the style and rapidity of the animals' movements might excite the admiration of the Tipton Slasher.

Strangely enough, these animals have their social distinctions almost as well defined as in the case of the human species. Thus, one herd will not, on any consideration, associate with another; each tribe has its rendezvous for morning and evening reunions, and each its leader or king, who is the first to raise an alarm on the approach of danger, and the first to lead the way, whether in ignominious

retreat, confronting a recognized foe, or standing at bay. These leaders are generally extremely cunning, one old stager with whom I was intimately acquainted having baffled all attempts to effect its capture for more than ten months. I got him at last by a stratagem. He had a knack of always keeping near a flock of sheep, and on the approach of the dogs dodged among them.

By this means he had always succeeded in effecting his escape, and more than that, this noble savage had actually drowned several of our best dogs, for, if at any time a dog came upon him at a distance from the sheep flocks, he would make for a neighboring swamp, on nearing which he has been known to turn round upon the pursuing dog, seize him, and carry him for some distance right into the swamp, and then thrust the dog's head under water, holding him there till he was drowned. It was amusing to see how some of our old knowing warrior dogs gave him best when they noticed that he was approaching a flock of sheep, well remembering, from former experience, that it was of no use trying to get him on that occasion, and that when near the water the attempt at his capture was both dangerous and impracticable.

If you take a new and inexperienced dog into your hunt after an old man, he invariably gets his throat ripped up, or is otherwise maltreated until well used to the sport. After a dog has had one season's experience he becomes a warrior, and it is a wonderfully clever kangaroo that can scratch him after he has attained that position. The young recruit, if we may so speak of a dog who has never had any practice, is over-impetuous, rushing into the treacherous embraces of the close hugger somewhat unadvisedly, and is fortunate if he escapes with his life as a penalty for his rashness. The dog of experience always gripes his marsupial adversary by the butt end of the tail, close to the rump, or at its juncture with the spinal vertebrae. Once the dog has thrown his kangaroo, he makes for the throat, which he gripes firmly, while at the same time he is careful to keep his own body as far as he conveniently can from the quarry's dangerous hind quarters. In this position dog and kangaroo work round and round for some time until one or the other of the combatants is exhausted. It is noteworthy that the kangaroo will only make use of its sharp teeth in cases of the direst extremity. On such occasions, however, it must be conceded that the bite is one of a most formidable character—one not to be any means underrated or despised.

Should those few incidents prove of sufficient interest in your estimation, I may state that I shall willingly, at some future time, forward you particulars of the "ways peculiar" of the emirs, bandicoots, wombats, opossums, and other remarkable animals, the observance of which formed almost my sole amusement during a rather lengthy sojourn in the bush of South Australia.

SEPTIMUS FREARSON.

Adelaide, S. A., April, 1883.

JAPANESE PEPPERMINT.

In more than one periodical the botanical name of this plant has been given as *Mentha arvensis*, var. *purpurascens*. It will be well, therefore, to point out that this is an error before the statement is further copied and the mistake perpetuated. The plant has green foliage, with not a trace of purple, and less deserves the name *purpurascens* than the true peppermint (*Mentha piperita*), of which a purplish leaved form is well known. The mistake probably arose in the first place in a printer's error. The history is as follows:

For some years past a large quantity of a substance called menthol has been imported into this country, and extensively used as a topical application for the relief of neuralgia, and in some instances as an antiseptic. This substance in appearance closely resembles Epsom salts, and consists of crystals deposited in the oil of peppermint distilled from the Japanese peppermint plant. This oil, when separated from the crystals, is now largely used to flavor cheap peppermint lozenges, being less expensive than the English oil. The crystals deposit naturally in the oil upon keeping, but the Japanese extract the whole of it by submitting the oil several times in succession to a low temperature, when all the menthol crystallizes out from the oil and falls to the bottom of the vessel. The source of the Japanese peppermint oil has been stated to be *Mentha arvensis*, var. *javanica*. On examining several specimens of this plant in our national herbaria I found that the leaves tasted like those of the common garden mint (*Mentha viridis*), and not at all like peppermint, and that therefore the oil and menthol could not possibly be derived from this plant.

I then asked my friend, Mr. T. Christy, who takes great interest in medicinal plants, to endeavor to get specimens from Japan of the plant yielding the oil. After many vain attempts, he at last succeeded in obtaining live plants. These were cultivated in his garden at Malvern House, Sydenham, and when they flowered I examined the plant and found that it differed from other forms of *M. arvensis* in the taste, in the acuminate segments of the calyx of the flower, and in the longer leaf stalks; the leaves also taper more toward the base. Dr. Franchet, the greatest living authority on Japanese plants, to whom I sent specimens, confirmed my opinion as to the variety deserving a special name, and M. Malinvaud, a well known authority on mints, suggested the name *piperascens*, which I adopted, calling the plant *Mentha arvensis*, var. *piperascens*. Specimens of the plant kindly lent by Mr. Christy for the purpose were exhibited by me at an evening meeting of the Linnean Society, and by a printer's error in the report of the remarks then made, the name of the plant appeared in print as *Mentha arvensis*, var. *purpurascens*.

I trust that the present note, through the medium of *The Garden*, will prevent the perpetuation of this error. This is the more important, as I hope that the plant will come into cultivation in this country. It is a robust plant of rapid growth, as easily cultivated as the English peppermint, and seems to require less moisture, and is therefore capable of cultivation in a great variety of localities. The increasing demand for menthol, which can only be procured in small quantities from the English peppermint, and the high price of English peppermint oil, lead to the hope that instead of importing menthol from Japan, it will be prepared in this country from the Japanese plant.

With the appliances of more advanced civilization, it ought to be possible for the oil and menthol to be made in this country at less price than the Japanese products now cost.

At the present time large quantities of cheap peppermint oil are imported into this country from the United States, and Chinese oil is imported into Bombay for use in the Government medical stores. There is no reason why this should be the case if the Japanese plant were cultivated in this country. In Ireland, where labor is cheap

and the climate moist, this crop might afford a valuable source of income to enterprising cultivators. It may be interesting to note here that the plant used in China closely resembles the Japanese one, differing chiefly in the narrower and more glabrous leaves. I have therefore named it *Mentha arvensis* f. *glabrata*, from specimens sent to me from Hong Kong, by Mr. C. Ford, the director of the Botanic Gardens there.

E. M. HOLMES.

GLADIOLUS.

THE gladiolus is easily raised from seeds, which should be sown in early spring in pots of rich soil placed in heat, the pots being kept near the glass after they begin to grow, and the plants being gradually hardened to permit their being placed out of doors in a sheltered spot for the summer. In October they will have ripened off, and must be taken out of the soil and stored in paper bags in a dry room secure from frost. They will have made little bulbs, from the size of a hazel nut downward, according to their vigor. In the subsequent spring they should be planted like the old bulbs, and the larger ones will flower during the season, while the smaller specimens must be again harvested and planted out as above described.

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